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# REPORT

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ON THE

## SCIENTIFIC RESULTS

OF THE

# VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

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DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

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## ZOOLOGY—VOL. XVI.

PART XLV.—REPORT ON THE STOMATOPODA

BY W. K. BROOKS

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# EDITORIAL NOTE.

THE collections of STOMATOPODA were placed in the hands of Professor W. K. Brooks of Johns Hopkins University, for examination and description, some years after the return of the Expedition. The collections contained few adult specimens, but were rich in larval forms obtained at the surface of the ocean, in many different localities, by means of tow-nets. Professor Brooks has thus been enabled to make a more extensive survey than heretofore of the relations between larvæ and adults, and to elucidate many points in their complicated life history. The Report thus forms a valuable contribution to a difficult subject, and will be welcomed by all Naturalists.

The Manuscript was received by me on the 31st December 1885.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 15*th August* 1886.

THE

# VOYAGE OF H.M.S. CHALLENGER.

## ZOOLOGY.

REPORT on the STOMATOPODA collected by H.M.S. Challenger during the Years 1873-76. By W. K. BROOKS, Associate Professor of Zoology and Director of the Marine Laboratory of the Johns Hopkins University, Baltimore, U.S.A.

### INTRODUCTION.

THE Stomatopoda are restricted to shallow waters, and as the small collection which was brought home by the Challenger, and entrusted to me for examination, contains no startling novelties, my first feeling, after my preliminary examination, was disappointment at the absence of any unfamiliar type, but this soon gave way to a feeling of excited interest after the discovery that the material in my hands furnished the most ample opportunities for tracing out, with great completeness, the phylogenetic and ontogenetic history of this small and compact order of Malacostraca.

The order Stomatopoda includes about sixty species of adults, and an equal or greater number of larvæ, from the tropical, subtropical, and temperate waters of the Atlantic, Pacific, and Indian Oceans. Some of the species, like *Gonodactylus chiragra*, range over the whole of this area, while others, like *Squilla nepa*, are distributed over the bottoms between the coast of Chili on the one side and the coasts of China and Africa on the other, or like *Squilla empusa*, between Rhode Island, U.S.A., and Africa. They are usually found in very shallow water, and, with the exception of the specimen of *Squilla leptosquilla* taken in the trawl by the Challenger in the Celebes Seas from a depth of 115 fathoms, and a specimen of *Lysiosquilla armata* which S. I. Smith found in the stomach of a *Lopholatilus* from 120 fathoms, they are all from very moderate depths, and the wide distribution of many of the species is undoubtedly due to the great length of their

larval life, during which they swim at the surface and are swept to great distances by the oceanic currents.

There are, however, many species which are known from only a single restricted locality, and almost one-fourth of the species which have been described are represented by solitary specimens, and there is therefore every reason to believe that many species, and possibly many genera, are still unknown, and that our knowledge of the group is very incomplete. They are extremely active in their movements and retiring in their habits, and they may remain undiscovered in a locality where they are abundant. A few species are recorded as dwelling in crevices in coral reefs, but most of them are burrowing animals. The living animals which form their prey are captured in the long raptorial claws, and some species, like *Squilla empusa*, often venture to a great distance from their burrows in their pursuit of prey, and are frequently captured in nets and trawls, although others, such as *Lysiosquilla excavatrix*, are the Myrmeleons of the ocean, lying in wait for their prey, covered with sand, with only the tips of their eyes exposed, at the mouths of their very deep burrows, to the bottoms of which they dart at the least alarm. At Beaufort, N.C., *Lysiosquilla excavatrix* is so abundant that the mouths of several burrows may often be found in shallow water in a square yard of the bottom, yet during the six summers I have passed there, I have obtained only one adult specimen which was captured outside its burrow, and only one which was obtained by digging. It was not until I devised the plan of holding near the mouth of the burrow with one hand a piece of bait, such as a small fish or a crushed crab, while the other hand was held ready with a trowel to cut off the retreat to the bottom of the burrow, that I was able to procure them in abundance, and the movements of this species are so very rapid that most of the specimens were so near escaping that they were cut in two when the trowel was plunged into the ground.

The Challenger collection of adults is a very small one, consisting of only fifteen species, but eight of them are new, while two of the others, *Squilla fasciata* and *Protosquilla* (*Gonodactylus*) *guerinii*, have been very inadequately described from single specimens. The importance of the collection must not, however, be estimated by its size, for it throws light upon many interesting problems, and furnishes the material for a more exhaustive and satisfactory discussion of the phylogenetic relationship and the natural classification of the various genera and species than has been possible hitherto.

The collection of pelagic Stomatopod larvæ is very rich, and it has yielded the material for tracing the history of several of the larval types, and also for establishing, in every genus except one, the connection between the adults and their larval types.

The larval history of the Stomatopoda is one of the most puzzling problems in morphology, and most of our knowledge of the subject is derived from Claus's well-known memoir.[1]

[1] Die Metamorphose der Squilliden, *Abhandl. d. k. Gesellsch. d. Wiss. Göttingen*, Bd. xvi. pp. 1–55, pls. i.–viii., 1871.

While I have been able to show, from the study of the Challenger specimens, that many of Claus's conclusions are incorrect, and that he referred some of the most familiar larval types to the wrong adult genera, I feel that I could not have accomplished this alone, and that, while my results are in many cases directly opposite to his conclusions, my ability to reach and to prove them is due, in a very great degree, to the study of his memoir. The labour of tracing the history of the larvæ has been so simplified through the accurate illustrations and ample and minute descriptions which he has furnished, that the investigator who follows him in this field has much of the difficulty removed, and, while I feel that I leave the subject in a much more satisfactory condition than that in which I found it, I also feel that I could not have made the same progress without the aid of his memoir.

The beautiful transparent, glass-like pelagic larvæ of the Stomatopoda are familiar to all naturalists who have had an opportunity to study pelagic life, and none of the animals which are captured at the surface in the tow-net exceed them in interest to the student, or in beauty and grace. Their perfect transparency, which allows the whole of their complicated structure to be studied in the living animal, their great size and rapacity, the graceful beauty of their constant and rapid movements, and the profundity of the morphological problems which they present for solution, cannot fail to fascinate the naturalist. Unfortunately they are as difficult to study as they are beautiful and interesting, and, notwithstanding their great abundance and variety, only two or three of them have been traced to their adult form.

Unlike most Malacostraca, the Stomatopods, instead of carrying their developing eggs about with them, deposit them in their deep and inaccessible burrows under the water, where they are aerated by the currents of water produced by the abdominal feet of the parent, which are so shaped as to form valves or paddles which exactly conform to the outline of the cylindrical hole. The eggs quickly perish when deprived of this constant current, and as it is very difficult to procure them at all, I know of no young Stomatopod which has been reared from an egg outside the burrow or in an aquarium. The older larvæ are hardy, and they thrive in small aquaria and moult into the adult form, but they are seldom found near the shore, and microscopic research is so difficult in mid ocean that almost nothing has been accomplished in this way. The younger larvæ are common near the shore, but they seldom pass through a moult in confinement, and the only way to trace the life-history of the Stomatopoda is therefore by the comparison of the series of larvæ which are collected in the ocean, and this is attended with peculiar difficulties, for the number of larval forms which have been described is much greater than the number of adults which are known, and many of them unquestionably belong to unknown species, and possibly to unknown genera.

The growth of the larvæ is very slow, and the larval life long, and as they are as independent and as much exposed to changes in their environment, and to the struggle

for existence as the adults, they have undergone countless secondary modifications which have no reference to the life of the adult, and are therefore unrepresented in the adult organism; and a comparison of the various larvæ which are here figured and described will show that they differ among themselves more than the adults, thus reversing the general rule that larvæ are less specialised and exhibit clearer evidence of genetic relationship than mature animals. The problem which they present is very similar to, but more difficult than, that presented by the Hydro-medusæ, for young Medusæ can be reared from the hydroids in aquaria without difficulty, and it is also easy to rear young hydroids from the eggs of Medusæ, but the life-history of the Stomatopoda must be traced from the internal and indirect evidence furnished by comparison.

The Stomatopod larvæ present differences among themselves, and they may be arranged in genera and species, but unfortunately their generic characteristics are quite different from those upon which the adult genera are based, and this is true in a still greater degree of their specific characteristics. As the larvæ undergo great changes during their growth, different stages have been described as distinct species or even genera, and it is not easy to select from the rich gatherings which are brought home by collectors, the successive stages in the history of a single species. Like the adults, they are widely distributed, and a gap in a series from the North Atlantic may be filled by a specimen from the coast of Australia or the Sandwich Islands, and the collection from a single locality may contain the larvæ of several widely separated species of adults in all stages of growth.

The attempt to unravel the tangled thread of the larval history of the Stomatopoda is therefore attended with very exceptional difficulties, and the earlier writers were content to rest after the bestowal of generic and specific names upon the larvæ, and the first writer to approach the subject in a scientific spirit was Claus, whose classical monograph not only abounds in fundamental generalisations of the greatest interest and value, but also contains nearly all that we know regarding the relationship between the larvæ and their adults; but the Challenger collections, especially the rich collections of *Alima* larvæ, a group in which Claus's collections were very deficient, furnish the material for revision of the subject, and enable us to determine, with much greater certainty than before, the larval type which pertains to nearly every one of the genera of adult Stomatopoda, and also to give a pretty complete picture of the developmental history of each larval type. As the specific differences between the adults are very slight, the specific identity of each larva can be determined only by rearing the adult from the larvæ, but this fact renders it the more important that the series collected by the Challenger should be figured and described, as later investigators will thus be enabled to complete the history by keeping the final stage in each series alive in an aquarium until it assumes the characteristic of the adult. This can be done without difficulty, as the older larvæ are hardy, while the fact that the younger larvæ will not live in captivity

frustrates the attempt to trace the gradual growth and metamorphosis of the larvæ in this way, and there is no other resource except comparison.

The first step in this direction is to trace the history of each larval type, by the selection and comparison of those larva which belong to the same series. In accomplishing this I have been guided in part by general resemblances, but more especially by comparative measurements. After I had tabulated the measurements in millimetres of a number of specimens, which resembled each other quite closely, and formed a tolerably complete series, I failed at first to trace through the columns of the table any such conformity to a general law as I had expected, but more careful examination indicated that this might be due to the fact that the history of the larva consists of metamorphosis as well as growth, and that the size of one organ might, when compared with that of another organ, show a gradual decrease during the successive stages, while its absolute size was actually increasing. I therefore reduced all my measurements to a common standard, and expressed them in thousandth parts of the total length of the larva at each stage instead of in millimetres, and I found that this at once introduced order where all had before been confused, and that, when thus reduced, the measurements usually enabled me to decide with confidence whether a given larva does or does not belong to a certain series.

In a few cases these comparative measurements gave proofs of specific identity which could hardly be made more conclusive by rearing the larvæ. Thus the lengths of the series of *Coronis* larvæ shown in Pl. XIII. figs. 1–8 are as follows, and if the length of the first stage be successively multiplied by five-fourths of itself, and this number by five-fourths of itself again, and so on, we obtain the series of numbers given in the second line, and as it is not conceivable that an accidental collection of larvæ should exhibit such exact conformity to a numerical law, we may feel certain that these larvæ are genetically related, that they belong to one species or else to closely related species, and that the series is consecutive, with the exception of one missing stage before the last.

| | | | | |
|---|---|---|---|---|
| 4·16 mm. | 5·29 mm. | 6·49 mm. | ... | 10·21 mm. |
| 4·16 „ | 5·20 „ | 6·50 „ | 8·13 mm. | 10·16 „ |

After one or two series had been traced out in this way, the general character of the metamorphosis itself became a trustworthy guide for establishing the series for a closely related species, and thus simplified the labour, and the next step was the reference of each larval type to its proper adult genus.

If the differences between the larvæ are due to secondary modification, we should not expect the larvæ of two distinct adults to become modified in the same way, and although it is of course possible that the larvæ of two closely related adults might

become divergently modified, or that two adults might diverge from each other while the larvæ remain alike, yet we should expect a natural or phylogenetic classification of the larvæ to stand in some definite and recognisable relation to the natural classification of the adults.

My attempt to discover a relation of this sort at once brought me face to face with a serious difficulty. In most of the published descriptions little attention is given to any points which are not regarded as diagnostic, and the resemblances, which are of even greater scientific interest than the differences, are often completely neglected; and careful study of the published figures soon showed that they are untrustworthy so far as relates to points which did not seem significant to the writers. Brevity and exactness of diagnosis is of course desirable and essential to the ready identification of species, but the description and identification of species is only a means for a more important end, the ultimate discovery of the laws of life, and it is therefore desirable that every specific description should consist of two parts, a brief diagnosis for purposes of identification, and a complete description, or brief monograph, giving all the characteristics; the points of resemblance to allied forms, as well as the distinctive peculiarities.

The absence of this information renders the establishment of phylogenetic relationships very difficult, and I soon found that the characteristics which are most significant and of most scientific importance are by no means the ones which have been selected for diagnosis. The analytical key which Miers[1] gives is probably the best which could be devised for ease of identification, and it expresses the general relationship between the genera with sufficient accuracy for the purposes of the systematist; but while most of the genera which are usually recognised are natural ones, the points which are of the greatest value in tracing the relation between the larvæ and the adults are entirely ignored in most of the published diagnoses.

While there can be no doubt that the many differences between the Stomatopoda and the other Malacostraca are of ordinal importance, all the species are included in a single family, the Squillidæ, and the differences between the genera are slight. Excluding the genus *Leptosquilla*, Miers, which is very slightly known, and not represented in the Challenger collection, six genera are usually recognised, *Squilla*, *Chloridella*, *Lysiosquilla*, *Coronis*, *Pseudosquilla*, and *Gonodactylus*.

The study of the Challenger specimens shows the necessity for redistributing the species which have been associated under the generic name *Gonodactylus*, and the establishment in its place of three genera, *Gonodactylus* (*sensu stricto*), *Protosquilla* n. gen., and *Coronida* n. gen., and also that it is impossible to draw any natural line between *Coronis* and *Lysiosquilla*, or between *Chloridella* and *Squilla*, and I therefore recognise seven genera, *Protosquilla*, *Gonodactylus*, *Pseudosquilla*, *Coronida*, *Lysiosquilla* (including *Coronis*), and *Squilla* (including *Chloridella*). My comparison of the

[1] On the Squillidæ, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. v. p. 2, 1880.

adults with the larvæ shows that the marginal spines of the telson present features which are of the greatest significance, and as I shall make frequent reference to these structures it will be convenient to give in this place a short description of them. The telson of a Stomatopod is usually furnished with six marginal spines (see Pl. I. fig. 3), which are arranged in three pairs, and which I shall designate as the primary marginal spines. The two nearest the middle line are the submedians; the two nearest the anterior edge, usually the farthest from the middle line, are the laterals; and the one between the lateral and the submedian on each side is the intermediate. Between these six primary marginal spines there are others which are equally large and prominent in the young larvæ, but minute or absent in the adults; these I call the secondary marginal spines.

## Analytical Key, giving the more prominent Diagnostic Characteristics of each Genus.

I. Sixth abdominal somite fused with telson; rostrum with acute median and antero-lateral spines.

*a*. Dactyle of raptorial claw dilated at the base and unarmed; hind body narrow and thick; marginal spines of telson crowded towards posterior edge.

Genus *Protosquilla* (Pl. XVI.).

II. Sixth abdominal somite distinct; rostrum without antero-lateral spines.

*a*. Hind body narrow and thick.

1. Dactyle of raptorial claw dilated at base, and unarmed; primary marginal spines of telson very large, with one or two secondary spines on each side between the submedian and the intermediate.

Genus *Gonodactylus* (Pl. XIV. fig. 1).

2. Dactyle of raptorial claw not dilated at base, usually armed with marginal spines; submedian spines of telson tipped with movable spinules; from one to three secondary spines between the submedian and the intermediate.

Genus *Pseudosquilla*.

*b*. Hind body depressed and wide.

1. Dactyle of raptorial claw dilated at the base and armed with marginal spines.

Genus *Coronida*.

2. Dactyle of raptorial claw not dilated at the base, but usually armed with marginal spines.

(1) Primary marginal spines of telson small, with no more than four secondary spines between the submedian and the intermediate; outer spine of basal prolongation of uropod usually longer than the inner; dactyle of raptorial claw with not less than six marginal spines.

Genus *Lysiosquilla* (Pl. X. figs. 8–16).

(2) Primary marginal spines of telson large, with more than four secondary spines between the intermediate and the submedian; inner spine of basal prolongation of uropod longer than outer; dactyle of raptorial claw usually with no more than six marginal spines.

Genus *Squilla* (Pls. I., II., III.).

In each of these genera there are certain characteristic or typical species, which are sharply cut off from all other genera, but it is difficult to give any absolutely diagnostic generic characteristics, as, in addition to the divergent and typical species, each genus also contains a few species which are more primitive, with the characteristics of the genus very slightly developed, and with features of resemblance to the primitive species in other genera.

The form of the dactyle of the raptorial claw affords a ready means for distinguishing species, and most of the genera are based upon peculiarities of this organ, which furnishes a tolerably satisfactory index of relationship, but gives no clue to the wider and more deep-seated affinities; but as soon as we ignore the preponderating importance which has been attached to the big claw, and take the whole organisation into consideration, we find that there are, in each genus, species which exhibit evidences of relationship to a common type or ancestral form, from which the various genera have diverged, and which was characterised by the possession of small, subcylindrical eyes, an acutely pointed rostrum, a smooth hind body, a short wide smooth carapace, very small antennary scales and uropods, and a telson which was wider than long, with the marginal spines crowded backwards, and the posterior border transverse, or nearly so.

From this primitive form, which is represented at the present day, probably with slight secondary modifications, by the various species which I have associated under the generic name *Protosquilla*, the various genera have diverged, and while it is not at all probable that any species which we know is the actual stem form of the order, yet there is ample evidence to show that this was characterised by the features which the various species of *Protosquilla* have in common, and that it must have been more nearly allied to them than to any other species with which we are acquainted. Thus, for instance, the

more typical species of the genus *Squilla*, such as *Squilla nepa*, have broad triangular eyes, an elongated carinated carapace with acute spines at its antero-lateral angles, longitudinal carinæ on all the abdominal somites, the appendages of the exposed thoracic legs filiform, and the telson longer than wide, with well-developed marginal spines, of which only the submedians are on the posterior border, and the others lateral. In *Squilla lata* (Pl. III. figs. 1, 2, 3) the eyes are narrow and only slightly enlarged at their tips, the appendages of the exposed thoracic limbs are flat, and the submedian carinæ are absent or obsolete on the first five abdominal and all the thoracic somites. In *Squilla fasciata* (Pl. III. figs. 4, 5) the eyes are cylindrical, not at all dilated at the tips, the appendages of the exposed thoracic limbs are flat and strap-shaped, and the submedian dorsal carinæ are completely absent on the first five abdominal somites; while in *Squilla chlorida* (Pl. II. figs. 1–5), which is not usually regarded as a *Squilla*, but is placed in a distinct genus *Chloridella*, the eyes are constricted at the tips, the appendages of the exposed thoracic appendages broad and flat, and the submedian carinæ absent from all the exposed somites except the sixth abdominal; and in *Squilla* (*Chloridella*) *microphthalma* the eyes and appendages are like those of *Squilla chlorida*, but the dorsal surfaces of the exposed somites are smooth, and their lateral edges but faintly carinated, and the telson is wider than long, and the uropods small. In all these species the antero-lateral angles of the carapace are acute, but in *Squilla* (*Chloridella*) *rotundicauda* we have, in addition to the wide telson the small uropods and eyes and antennary scales of *Squilla microphthalma*, a loosely articulated hind body, a carapace which is rounded in front as well as behind, and the posterior margin of the telson rounded.

The series is so complete that it is quite impossible to draw any line to separate the genus *Squilla* from the genus *Chloridella*, and all the species must therefore be associated in a single genus *Squilla*. It is easy to find an answer to the question, which term in the series of species of *Squilla* is most primitive, for while the large multi-carinated *Squillæ* are so different from the *Lysiosquillæ* that there can be no question as to their distinctness, it is difficult to discover any characteristics which shall separate *Squilla microphthalma* from the latter genus; but we find that this species does not resemble all species of *Lysiosquilla* to an equal degree, for the genus includes species, like *Lysiosquilla* (*Coronis*) *excavatrix* (Pl. X. figs. 8–16), which have, like *Squilla microphthalma*, small eyes and uropods, and flat wide appendages to the exposed thoracic limbs; as well as species which, like *Lysiosquilla maculata*, have these appendages linear and the eyes broad and triangular. We may therefore state with confidence that *Lysiosquilla maculata* and *Squilla nepa* are more divergent than *Lysiosquilla excavatrix* and *Squilla microphthalma*, and that the two genera are divergent branches from a common type, from which both genera have inherited the flat hind body and the many-spined raptorial claw; and that this ancestral form had small eyes, antennary scales and uropods, and a transverse telson.

This ancestral form must have been very similar to two closely related living species, *Squilla bradyi*, Milne-Edwards, and *Gonodactylus trachurus*, Miers, which are referred by Miers to the genus *Gonodactylus* on account of the enlargement of the base of the dactyle, and to *Squilla* by Milne-Edwards on account of the presence on the same organ of marginal spines, and the flatness of the hind body. Their points of resemblance to *Gonodactylus* are also points of resemblance to *Protosquilla*, and as they differ from all the species of *Gonodactylus* in the flatness of the hind body, and the presence of spines on the dactyle, there can be no doubt of the propriety of placing them in a distinct genus, for which I propose the name *Coronida*. *Coronida* has, like the convergent species of *Lysiosquilla* and *Squilla*, small eyes, antennary scales and uropods, a flat hind body, an armed dactyle, and a wide rounded telson, and there can therefore be no doubt of its close relationship to the ancestral type of these genera.

The species of *Coronida*, *Pseudosquilla* and *Gonodactylus*, are closely related, but not in such a way as to indicate that any one genus is the ancestor of the others. The two latter resemble each other, and differ from the first, in the fact that the hind body is convex and narrow and bent downwards at the tip, while it is straight and flat and wide in *Coronida*.

*Gonodactylus* and *Coronida* resemble each other and differ from *Pseudosquilla* in the presence of an enlargement at the base of the dactyle of the raptorial claw, while *Pseudosquilla* and *Coronida* resemble each other and differ from *Gonodactylus* in the presence of marginal spines on the dactyle.

This triangular relationship can be accounted for only on the hypothesis that they are the divergent descendants of an ancestral form which each one of them resembles in certain features, to which, in each genus, secondary differences have been added.

As there is no reason to suppose that this divergence is recent, we should not expect to find this ancestral form still represented by living species, but as the living species of *Protosquilla* exhibit, like this hypothetical stem form, features of resemblance to each of these genera, it is not only probable, but almost certain, that they are much more directly descended from the ancestral form than any of the species of *Gonodactylus* or *Pseudosquilla* or *Coronida*; and, of course, than any of the *Lysiosquillæ* or *Squillæ*.

*Protosquilla* resembles *Gonodactylus* in the small size and flatness of its carapace, in the presence of an acute spine on the rostrum, in the unarmed dactyle dilated at its base, in the height of the narrow hind body, the terminal somites of which are bent downwards, and also in the small size of most of the species.

It also resembles *Pseudosquilla* in most of these features, but the dactyle of *Pseudosquilla* is without the basal enlargement, and is usually armed, like that of *Coronida* and the *Squillæ* and *Lysiosquillæ*.

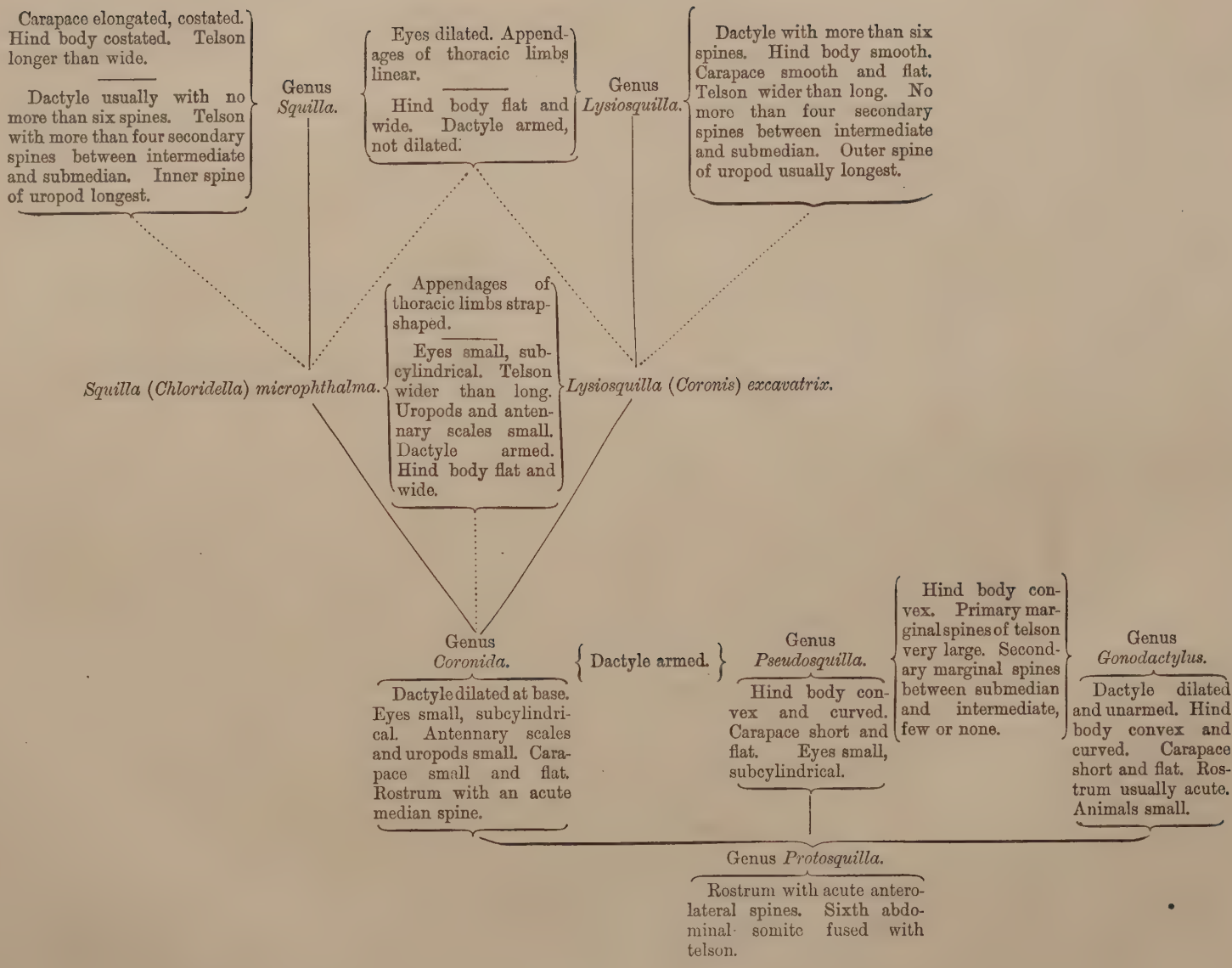
*Coronida* resembles *Protosquilla* in the small size of its eyes, antennary scales and uropods, the flatness of the small carapace, the enlargement of the base of the dactyle,

and the presence of a median spine on the rostrum, while *Protosquilla* differs from all other Stomatopoda in the length of the acute median spine of its rostrum, and in the presence of acute long spines on its antero-lateral angles, and the union of the sixth abdominal somite with the telson; and as it also exhibits, in its long rostrum, rudimentary uropods, and in the absence of a distinct sixth abdominal somite, a closer resemblance than any other adult to the Stomatopod larva, there can, I think, be no doubt that it is the most primitive genus in the order.

I have attempted to give a graphic representation, in the following diagram, of the relationships between the genera of adult Stomatopoda, the heavy lines indicating their convergent relationship to each other and to *Protosquilla*. The characteristics which are joined by brackets to two or more genera are the features of resemblance between those genera, while those characteristics which are thus joined to only one genus are confined to this genus.

The diagram is intended to express the relationship between the genera as established by the comparative study of all the species; and as it often happens that a feature which is highly characteristic of a genus as a whole may be absent or modified in a few exceptional species, the diagram cannot be used as a means of diagnosis. For example, the *Lysiosquillæ* have, as a rule, the outer one of the two spines on the ventral prolongation from the posterior edge of the basal joint of the uropod longer than the inner, and I have therefore given this feature as characteristic of the genus; for the study of the larvæ shows that it is very significant, although it happens that there are one or two species in which the inner spine is the longest.

While I trust that the diagram is quite intelligible, a word of explanation may be desirable; thus, the genus *Coronida* is shown, by the brackets, to share with *Chloridella*, *Coronis*, and *Protosquilla*, its small eyes, uropods, and antennary scales; with *Chloridella*, *Coronis*, and *Pseudosquilla* the armed dactyle; and with *Protosquilla* the small flat carapace and acute rostral spine.


Carapace elongated, costated. Hind body costated. Telson longer than wide.
Dactyle usually with no more than six spines. Telson with more than four secondary spines between intermediate and submedian. Inner spine of uropod longest.
Genus *Squilla*.
Eyes dilated. Appendages of thoracic limbs linear.
Hind body flat and wide. Dactyle armed, not dilated.
Genus *Lysiosquilla*.
Dactyle with more than six spines. Hind body smooth. Carapace smooth and flat. Telson wider than long. No more than four secondary spines between intermediate and submedian. Outer spine of uropod usually longest.
*Squilla* (*Chloridella*) *microphthalma*.
Appendages of thoracic limbs strap-shaped.
Eyes small, subcylindrical. Telson wider than long. Uropods and antennary scales small. Dactyle armed. Hind body flat and wide.
*Lysiosquilla* (*Coronis*) *excavatrix*.
Genus *Coronida*.
Dactyle armed.
Dactyle dilated at base. Eyes small, subcylindrical. Antennary scales and uropods small. Carapace small and flat. Rostrum with an acute median spine.
Genus *Pseudosquilla*.
Hind body convex and curved. Carapace short and flat. Eyes small, subcylindrical.
Hind body convex. Primary marginal spines of telson very large. Secondary marginal spines between submedian and intermediate, few or none.
Genus *Gonodactylus*.
Dactyle dilated and unarmed. Hind body convex and curved. Carapace short and flat. Rostrum usually acute. Animals small.
Genus *Protosquilla*.
Rostrum with acute antero-lateral spines. Sixth abdominal somite fused with telson.

## The Accessory Copulatory Organs of the Male Stomatopod.

Before I end the discussion of the phylogenetic relationship between the genera of adult Stomatopoda, I wish to call attention to the importance of figures and descriptions of the complicated structure on the first abdominal appendage of the male. If each description of a new species contained a figure of this structure, the tracing out of the genetic relationship between the species would be greatly simplified; although a knowledge of this organ would, of course, be of no help in our present undertaking, the discovery of the connections between the pelagic larvæ and the adults. Unfortunately the Malacologists have given little attention to this structure, as it cannot be studied to advantage without removing it from the body and mounting it as a microscopic object.

In the case of the Challenger specimens Mr. G. B. Haldeman has kindly done this for me, and has also made the drawings of this organ which are here given.

The endopodite of the first abdominal appendage of the male Stomatopod is furnished, on its inner edge near the tip, with a complicated grasping organ which probably serves for seizing the female, like the grasping forceps of many of the lower Crustacea and some few of the Malacostraca, although I am acquainted with no observations as to their use in the Stomatopoda. The structure has been figured by several observers, but no careful comparative description has ever been published, although it often presents characteristics of specific value, and differs conspicuously in the different genera. One of the most interesting and valuable peculiarities of the organ is that it seems to illustrate the degree of relationship between the various genera, and an exhaustive study of its modifications in the different species will be a very great aid in tracing the phylogeny and genetic relationship of the various genera and species. Unfortunately, several of the new species in the Challenger collections are represented only by female specimens, and the material is too scanty to afford an opportunity for the exhaustive study of the subject, but I am able to give, with the descriptions of several of the new species, figures and descriptions of this structure, and I hope that these descriptions will serve to incite in some one who has access to larger collections a desire to make a more thorough study of it.

The endopodite of the first abdominal appendage of the male Stomatopod consists of a large flat basal joint (Pl. I. fig. 2, A) separated by a movable transverse suture *c* from the terminal joint B, which is notched or bilobed at the tip, and thus completely or incompletely divided into an external leaflet *a*, and an internal one *b*. The latter carries on the anterior surface of its inner edge, at the line of articulation with the proximal joint, the petasma, or forceps, which consists of three portions: (1) the retinaculum or appendix interna *d*, which is rounded at its proximal end, prolonged into a long acute or subacute point distally, and with a straight internal edge which is closely set with several crowded rows of hooked spines which interlace on the middle line with those of the corresponding appendage on the opposite side of the body; (2) the

movable limb *f* of the forceps, which is furnished with a large muscle which runs up into its hollow base, while its tip is spoon-shaped on its external surface which is opposed to the third portion, the fixed limb, *e*, of the forceps. This is a raised ridge on the flat surface of the appendage, with its tip free, and, in most cases, bent into a hook, which is curved towards the spoon-like hollow at the tip of the movable limb.

In *Gonodactylus* (Pl. XV. fig. 4) the terminal joint A is divided into two lobes, *a* and *b*, by a marginal notch, but the inner lobe is not separated from the outer one by a suture. *Pseudosquilla* has justly been regarded, by nearly all writers on the Stomatopoda, as very closely related to *Gonodactylus*, and the modified appendage (Pl. XV. fig. 10) is very similar indeed to that of the latter genus, as will be seen by comparing the figure with that of *Gonodactylus graphurus* (Pl. XV. fig. 8). In both, the inner lobe of the terminal joint is larger than the outer one, and separated from it by a marginal notch but not by a suture.

The close relationship between *Squilla* and *Chloridella* is unquestioned, and I have shown that the species which have been divided between the two genera really form a single phylum or stem which cannot be divided into two genera. A comparison of the modified abdominal appendage of the male *Squilla leptosquilla* (Pl. I. fig. 2), or that of *Squilla quinquedentata* (Pl. II. fig. 6), with that of *Squilla* (*Chloridella*) *chlorida*, will show that there is the closest resemblance. In all these the outer lobe *a* of the terminal joint is separated by a suture from the inner lobe, the tip of which is elongated considerably in advance of the tip of the outer lobe, although the more primitive rank of *Squilla chlorida* is shown by the fact that the separation between the two lobes is much less pronounced than it is in the more typical and highly modified *Squilla*. I have shown that the species of *Lysiosquilla* and *Coronis* also form a single phylum, which it is not practicable to divide into two genera, and the character of the modified appendage is as similar in *Lysiosquilla maculata* (Pl. X. fig. 6) and *Lysiosquilla* (*Coronis*) *excavatrix* (Pl. X. fig. 12) as it is different from that of *Gonodactylus* and *Squilla*. The terminal joint B is subtriangular, and the suture *c* which separates it from the proximal joint is transverse, while it is oblique in the other forms. The outer lobe *a* is very much larger than the inner *b* and triangular, while the inner lobe is very small and nearly circular, and separated by a movable suture from the outer. The movable limb of the forceps *f* is greatly elongated and is not bent at the tip, while the fixed limb *e* is very small and rounded at the tip.

While no classification can ever be accepted as final, the one which I have expressed in the preceding diagram is at least an approximation to the truth, and gives, so far as our present knowledge enables us to trace it, the genealogy of the species of Stomatopoda, so far as this can be established from the study of the adults.

In most animals we look to the larvæ or embryos for evidence of genetic relationship, more satisfactory and intelligible than any which is furnished by the adults, for it is a

general rule, in the animal kingdom, that the larvæ or young of related species are less divergent than the mature animals. Even if we were able to rear the larvæ of the Stomatopods, and thus to use the evidence which they supply, this rule would not apply in this case. The larval life is so long, and forms such a considerable part of the total life of each individual, and the larvæ are so perfectly developed, and their relations to their environment so complex, that there are about as many species of larva as of adults, and the specific differences between them are fully as pronounced; while the differences between different genera of larvæ are often greater than those between the genera of adults. The fully grown larvæ are in no sense embryonic or generalised; they have no reproductive organs, but in all other particulars they are just as highly organised as the mature animals, and if the animals were to become sexually mature while retaining the organisation which fits them for their pelagic life, and if the final sedentary stage were then dropped, we should then have an order of pelagic Crustacea of as high organisation, and with as many well-defined genera and species, as the order Stomatopoda.

The larvæ may thus be treated exactly as if they were adults, and a natural or phylogenetic classification of them established by the comparative study of their organisation exactly as we have done for the adults.

As each larva is only an immature adult, or each adult only a fully grown larva, the genetic history of each specific adult must be identical with that of some specific larva, namely, its own larva.

If, then, comparative anatomy enables us to trace from the study of the adults of an order or family or genus, their natural or genealogical classification, it must of course be possible to do the same thing with the larvæ, and if the classification which is established is natural, there must be a discoverable relation between the one derived from the larvæ and the one derived from the adults.

In most cases this is unnecessary, as we are able to trace the young to its adult form, and to use the whole life history as a basis for classification, and in most cases it would also be extremely difficult, on account of the embryonic or generalized character of young animals, and the absence of conspicuous specific differences, but it fortunately happens that in the Stomatopoda, where we are compelled to resort to this or some other indirect method for discovering what larva pertains to what adult, it is also much more easy than usual, owing to the high specialisation and great diversity of the larvæ.

We cannot expect absolute agreement between the two classifications, for the sources of our evidence can never be complete. We knew nothing of the larval types which may have existed in the past, and next to nothing of the fossil adults, and it is very probable that some of the larvæ belong to unknown adults, and also that the larvæ of some of the known adults are as yet undiscovered, and it is very probable that two allied adults may have remained alike, while their larvæ have been modified in two divergent directions,

and that two allied species of adults may have originated in the same manner from a common type, while their larvæ have remained alike.

Still, after all these allowances, it still remains true that, inasmuch as the larvæ of two closely related species are themselves more closely related by blood than the larvæ of more widely separated species, their bodily structure must exhibit a record of this relationship which can be discovered by study and comparison, and which will agree to some extent with the record presented by the organisation of the adults; the degree of agreement depending upon the completeness of the two records and the correctness of our interpretation.

What then is the natural or phylogenetic classification of the Erichthidæ or Stomatopod larvæ when they are studied by themselves and treated as adult animals?

The genera of Erichthidæ which have been recognised by the systematists are *Erichthoidina*, *Erichthus*, *Squillerichthus*, and *Alima*, and of these four the first, *Erichthoidina*, is simply a young *Erichthus*, and the third, *Squillerichthus*, a fully grown larva of the *Erichthus* type, so that the genera become reduced to two, *Erichthus* and *Alima*. Of these two genera, one, *Alima*, is much more sharply defined than the other, *Erichthus*, which contains a number of divergent types which admit of definition. Three of these types are represented in the collection by numerous species, and are well known. As it will be convenient to have names for them I shall use names which indicate the adult genera or subgenera to which they are to be referred.

The *Gonerichthus* type, which Claus correctly refers to the genus *Gonodactylus*,[1] for reasons which receive added weight from the study of the Challenger specimens, is shown in Pl. XV. fig. 6.

The *Pseuderichthus* type, which Claus has given very conclusive reasons[2] for regarding as the young of *Pseudosquilla*, is shown in Pl. XII. fig. 6.

The *Lysioerichthus* (Pl. XI. figs. 1–5), which Claus erroneously regards as the young of *Squilla*,[3] is, as I shall show, the young of *Lysiosquilla*. These three groups, together with *Alima* (Pl. I. figs. 4, 5), which Claus regards as the young of *Lysiosquilla*,[4] but which, as I shall show, is confined to the genus *Squilla* and diagnostic of this genus, include nearly all the Stomatopod larvæ, although there are a few larvæ which have a more isolated position, such as the one shown in Claus's fig. 14, which I shall designate as *Erichthalima*, and others which are intermediate between the three *Erichthus* types. The statement on p. 610 and footnote in Claus's Grundzüge der Zoologie, that he has shown from the study of alcoholic specimens that *Alima* is the young of *Squilla* will seem to conflict with my own statement that he regards *Alima* as a young *Lysiosquilla*, but a reference to pp. 132, 133, 134, 135, 136, 138, and 154 of his Monograph will show that he refers a number of *Erichthus* larvæ to the genus *Squilla*,

[1] Metamorphose der Squilliden, pp. 138 and 139.
[2] Metamorphose der Squilliden, pp. 140–146.
[3] Metamorphose der Squilliden, pp. 132, 133, 134, 135, 136, and 138.
[4] Metamorphose der Squilliden, p. 154.

and he gives at length, on p. 154, his reasons for regarding *Alima* as the young of *Lysiosquilla*. It is true that he regards *Lysiosquilla* as a branch from the *Squilla* stem, and that in this sense he does hold that *Alima* is a *Squilla* larva, but I suppose no one would now regard *Lysiosquilla* as a *Squilla*.

A comparison of these larvæ with each other indicates that they are all derived from a primitive larval type which was hatched from the egg as an *Erichthoidina*, and reached its final form by gradual growth, and an increase in the number of somites and appendages, without any sudden change or the retrograde development of any of its appendages. It was furnished with a deep carapace, which, however, was not folded inwards at its ventral edges, and it was probably armed with a number of secondary spines between the submedian and intermediate spines of the telson, and the edge of the carapace was probably serrated. The most primitive among the recent adult Stomatopoda might be expected to retain the most primitive larval type. We know of no fully grown larva which can safely be referred to the genus *Protosquilla*, but the primitive larva must have been very similar to what we should have if the *Erichthoidina* shown in figs. 1 and 2 of Pl. XII. were to grow up and acquire its full number of somites and appendages, while the carapace and telson remained without change. The *Gonerichthus* larva (Pl. XV. figs. 1, 3, 6, 11) passes through an *Erichthoidina* stage, its appendages undergo no retrograde metamorphosis, the hind body is convex, the carapace is deep but not folded inwards, there are no secondary spines, or only one or two on the telson between the submedian and the intermediate, the primary spines of the telson are long, and the outer spine of the basal prolongation of the uropod is very much longer than the inner, and no specimens have ever been found with marginal spines on the edge of the long slender dactyle. The last four characteristics are also characteristics of the adult *Gonodactylus*.

In *Pseuderichthus* (Pl. XII. fig. 6) the carapace is deep and very slightly infolded along its lateral edges, the hind body is convex, the dactyle of the raptorial claw of the older larvæ sometimes show traces of marginal spines, the outer spine of the uropod is very much longer than the inner, and the primary marginal spines of the telson are very long, the submedians are tipped with movable spinules, and there are only one or two secondary spines between the submedian and the intermediate. None of these characteristics are absolutely diagnostic of the genus *Pseudosquilla*, but as all except the last are true of the adults of this genus, it is probable that all these larvæ are *Pseudosquillæ*, like the one the history of which has been traced by Claus. If this larva hatches as an *Erichthoidina* it must undergo retrograde metamorphosis, since the younger larvæ have no appendages on the third and fourth or fifth thoracic somites.

In *Erichthalima*[1] the carapace is deep, and its lateral edges are infolded over the ventral surface, and serrated, the hind body is flat, the telson is wider than long, there

[1] Claus, Metamorphose der Squilliden, fig. 14.

are numerous secondary spines on the telson between the submedian and the intermediate, and the dactyle of the raptorial claw is armed with several teeth. In this last respect, and in the flatness of the hind body, it resembles *Squilla* and *Lysiosquilla*, and it also resembles all the *Squillæ*, and differs from all the *Lysiosquillæ* in the great number of secondary spines on the telson, while it resembles the *Lysiosquillæ* and differs from all the *Squillæ* except the most primitive in having the telson wider than long. It resembles the most primitive species of both genera in the small size of its uropods, and Claus's description renders it probable that the adult form to which it gives rise has a long acutely pointed rostrum, thus differing from both *Squilla* and *Lysiosquilla*.

The fact that some of its characteristics are shared by the adults of both these genera, while others are confined to one and still others to the other, while still others are not found in either of them, indicates that its adult may be equally related to but distinct from both of them. Its relation to the *Lysioerichthus* and *Alima* larvæ is of precisely the same character.

The *Lysioerichthus* larva probably passes through an *Erichthoidina* stage, with retrograde metamorphosis of the third, fourth, and fifth thoracic appendages. The carapace is very deep, and in the older larvæ its lateral edges are folded inwards, and they are serrated in the younger larvæ; the dactyle usually bears traces of more than six marginal spines, the hind body is flat and wide, the outer spine of the uropod is nearly always longer than the inner, the telson is wider than long, and there are from one to four spines between the submedian and intermediate, and sometimes a larger number in the very young larva.

There is no evidence that the *Alima* larva ever leaves the egg as an *Erichthoidina*. The third, fourth, and fifth, as well as the three following thoracic appendages, are wanting in the youngest larvæ. The carapace is shallow and flat, and its lateral edges are serrated throughout the whole larval life. The dactyle bears traces of marginal spines which are never more than six in number, the hind body is flat and wide, the telson is longer than wide, except in *Alimerichthus*, and there are numerous secondary spines between the submedian and the intermediate.

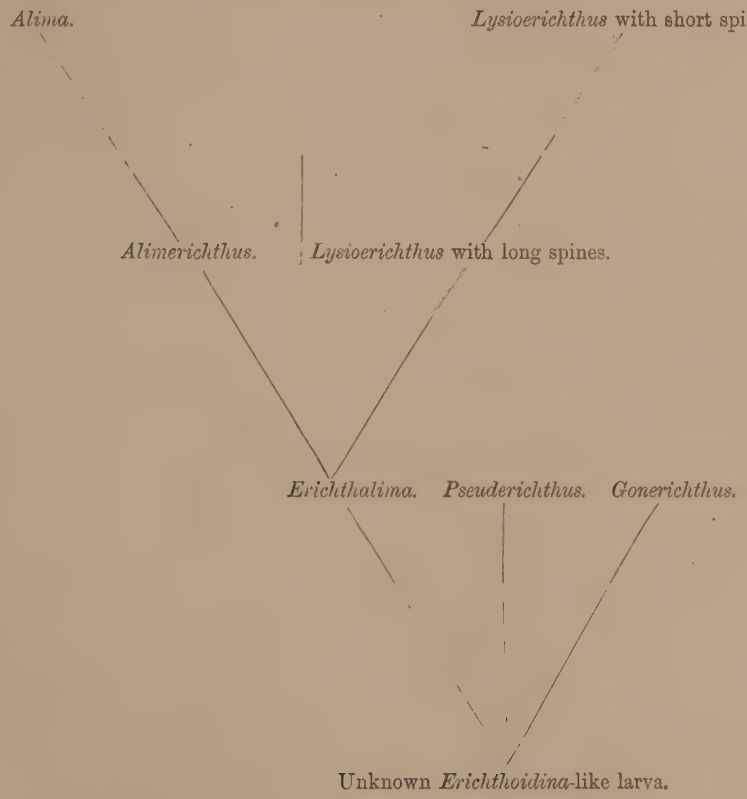
In the flatness of the hind body and the presence of spines on the dactyle, *Erichthalmia* resembles both *Lysioerichthus* and *Alima*. It resembles the very young *Lysioerichthus*, and *Alima* at all stages, in the serration of the lateral edges of the carapace, while it resembles all *Lysioerichthi* and differs from all *Alimæ* except *Alimerichthus*, in having the telson wider than long. It resembles all the fully grown *Lysioerichthi* and differs from all *Alimæ* in having the carapace very deep, with its lateral edges infolded, and it differs from all *Lysioerichthi* and resembles all *Alimæ* in having more than four spines between the submedian and intermediate spines of the telson. *Lysioerichthus* has the outer spine of the uropod usually longest, while the

inner is always longest in *Alima*. In *Erichthalima* they are equal, and both very short, as is also the case in some of the more primitive *Lysiosquillæ*, and in *Protosquilla*.

It will thus be seen that *Erichthalima* has certain characteristics which are found nowhere else except in *Alima* or *Squilla*, and others which are found nowhere else except in *Lysioerichthus* or *Lysiosquilla*, and others which are common to both, and others which are found in neither. We must therefore regard it as a more primitive larva than either, equally related to both.

In the *Lysioerichthus* series we have forms which, like *Alima*, have the rostrum and postero-lateral spines long, and others which have them short. And in the *Alima* series we have *Alimerichthus* which has its carapace deep and its telson wider than long, as in *Lysioerichthus*, while the carapace is flat and the telson longer than wide in all the other *Alimæ*.

The relationship between these various larvæ may then be expressed in a diagram as follows :—




This classification exactly matches the one given for the adult Stomatopoda on page 12, and, added to the fact that the few larvæ which have been traced to their

adult Stomatopods fall into their proper places, it furnishes very satisfactory proof of the relationship between the larvæ and their adults.

Faxon has reared a *Squilla empusa* from an *Alima* larva. The Challenger collections show that the larva of *Lysiosquilla maculata* is one of the short-spined *Lysioerichthi;* I have reared *Lysiosquilla* (*Coronis*) *excavatrix*, one of the more primitive *Lysiosquillæ*, from a long-spined *Lysioerichthus*. Claus has figured a series which shows beyond question that at least one species of *Pseuderichthus* becomes a *Pseudosquilla*, and the Challenger collections furnish equally good proof that the *Chiragra* group of *Gonodactyli* come from *Gonerichthus* larvæ, and I therefore believe that we may very safely assume that all the *Lysioerichthus* larvæ are young *Lysiosquillæ*, all the *Alima* larvæ young *Squillæ*, *Alimerichthus* one of the lower *Squillæ* or *Chloridellæ*, all the *Gonerichthi* young *Gonodactyli*, *Erichthalima* very probably a young *Coronida*, and all the *Pseuderichthi* very probably young *Pseudosquillæ*. The evidence for this conclusion can be much better estimated after the examination of the special descriptions which follow.

## LIST OF SPECIES IN THE COLLECTION.

The small collection of adult Stomatopoda consists of the following fifteen species, of which eight are new, while two of the others, *Squilla fasciata* and *Protosquilla* (*Gonodactylus*) *guerinii*, have been only imperfectly described from single specimens.

As there are few adults which have been traced to their larvæ, and as I am able to give, from the study of the living specimens, an account of the metamorphosis of an undescribed species, *Lysiosquilla* (*Coronis*) *excavatrix*, I have added a systematic description of it, with illustrations, and hence the Report contains notes on the following sixteen species:—

*Squilla nepa*, Latreille. Five males and two females from Pokoska, Japan, taken with the trawl in 5 to 25 fathoms; one male from Kobé, Japan, 8 to 50 fathoms; one female from Reefs at Honolulu; one female taken with the trawl in 15 fathoms, on the coast of Japan, at Station 233B, lat. 34° 18′ N., long. 133° 35′ E.

*Squilla quinquedentata*, n. sp. One male from 28 fathoms, at Station 188, in the Arafura Sea, lat. 9° 59′ S., long. 139° 42′ E.

*Squilla leptosquilla*, n. sp. One male taken with the trawl in 115 fathoms in Celebes Sea, near the Philippine Islands, in lat. 12° 28′ N., long. 22° 15′ E.

*Squilla chlorida*, n. sp. One male specimen from a depth of 15 fathoms at Amboina, Moluccas.

*Squilla fasciata*, De Haan. One male and one female from 15 fathoms, at Station 233B, in the Inland Sea, Japan, lat. 34° 18′ N., long. 133° 35′ E.

*Squilla lata*, n. sp. Two males and one female from 49 fathoms in the Arafura Sea, New Guinea, Station 190, lat. 8° 56′ N., long. 136° 5′ E.

*Lysiosquilla maculata*, Miers. One mature male from Amboina, one half-grown male from Samboangan, and a mature male and female from Samboangan.

*Pseudosquilla ciliata*, Miers. One male and one female from 2 fathoms at St. Thomas; one male from Reefs at Honolulu.

*Gonodactylus chiragra*, Latreille. Numerous males and females from St. Thomas; one male from Bermuda; one male from Station 36, lat. 32° 7′ 25″ N., long. 65° 4′ W., near Bermuda; two from Samboangan, and one from Samboangan Reefs.

*Gonodactylus chiragra* (var. *minutus*). Numerous male and female specimens from near Cape St. Roque.

*Gonodactylus* (juv.). Perhaps a young *Gonodactylus chiragra*, from Station 208, near Philippine Islands; 18 fathoms.

*Gonodactylus graphurus*, White. One male and one female from 8 fathoms, at Station 186, near Cape York, in lat. 10° 30′ S., long. 142° 18′ E.

*Gonodactylus glabrous*, n. sp. One female specimen from the Reefs at Samboangan.

*Protosquilla* (*Gonodactylus*) *elongata*, n. sp. One female specimen from St. Vincent, Cape Verde Islands.

*Protosquilla* (*Gonodactylus*) *cerebralis*, n. sp. One specimen from Fiji.

*Protosquilla* (*Gonodactylus*) *guerinii*, White. One female specimen from Honolulu.

*Lysiosquilla* (*Coronis*) *excavatrix*, n. sp. From Beaufort, N.C., U.S.A.

# DESCRIPTIONS OF GENERA AND SPECIES.

## Order STOMATOPODA.

### Family Squillidæ.

### Genus *Squilla*, Fabricius.

*Diagnosis.*—Stomatopoda with the sixth abdominal somite separated from the telson by a movable joint; the hind body depressed and wide; the dactyle of the raptorial claw without a basal enlargement, but with a series of spines, which are not usually more than six in number, on its inner edge; more than four secondary spines between the intermediate and submedian spines of the telson, which is usually longer than wide; inner spines of ventral prolongation from basal joint of uropod longer than the outer. Larva an *Alima* with the ocular and antennulary somites not covered by the carapace; the lateral edges of the carapace not reflected, but usually bordered by small spines or serrations; the inner spine of the ventral prolongation from the basal joint of the uropod longer than the outer, and the telson with more than four secondary spines between the intermediate and submedian spines.

*Remarks.*—I have had an opportunity to study the first abdominal appendage of the male in only a few species of *Squilla*, but this organ has well defined common characteristics in all these species, and we may probably add to the diagnostic characteristics given above, the statement that the inner lobe of the terminal joint of the first abdominal appendage of the adult male is longer than the outer, and separated from it by a suture.

While recognising the very close relationship between the genus *Chlorida* (Eydoux and Souleyet) and the genus *Squilla*, Miers thinks that the former genus is a natural one, which should be retained under the modified name *Chloridella*[1] to include the Stomatopoda which have the dactyle of the raptorial claw armed with marginal teeth and without a basal enlargement; the carapace and hind body without longitudinal carinæ; the eyes dilated in the middle and contracted at the tip; the rostrum short; the carapace small and short, and the appendages of the thoracic limbs strap-shaped,

[1] Miers, On the Squillidæ, p. 13.

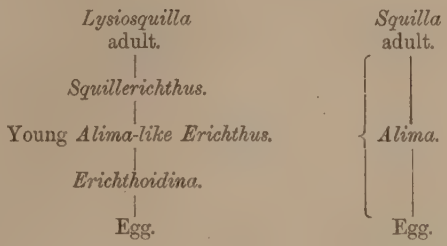
while the genus *Squilla* is restricted by him to those species which, with a similar raptorial claw, have longitudinal carinæ on the carapace and hind body; the eyes not constricted at the tips; the carapace elongated, and the appendages of the thoracic limbs slender and styliform.

The forms which he includes in the genus *Chloridella* are certainly less specialised than the higher *Squillæ*, but the Challenger collections show that they are connected with the latter by intermediate forms in such a way that it is impossible to draw a line between them, and that they do not form two divergent branches, but a single series. *Squilla lata*, n. sp. (Pl. III. figs. 1, 2, 3), is a *Squilla*, according to Miers's definition, while *Squilla chlorida*, n. sp. (Pl. II. figs. 1–5), is a *Chloridella*, but *Squilla fasciata* (Pl. III. figs. 4, 5) is so very similar to both of these species that it is very hard to distinguish from them, and it is intermediate between them in respect to the very characteristics upon which Miers bases his genera. We must therefore enlarge the genus *Squilla* to include the *Chloridellæ*.

*Ontogeny.*—The *Alima* larva is one of the most sharply defined larval types, and we have every reason to believe that all the larvæ in this group pertain to closely related adults. As one of them has been kept by Faxon in an aquarium until it changed into a young *Squilla*, and as all the species of the genus *Squilla* agree with each other in several features which are not united in any other adult Stomatopod; the flatness of the hind body, the small number of marginal spines on the dactyle, the great number of secondary spines on the telson between the intermediate and the submedian marginal spines, and the greater length of the inner one of the two spines on the basal prolongation of the uropod; and as all the *Alima* larvæ, including *Alimerichthus*, agree with each other, and differ from all other Erichthidæ except the anomalous *Erichthalima*, in similar features, we can state with confidence that all *Alima* larvæ are young *Squillæ*, and that all *Squilla* larvæ are *Alimæ*.

While the *Alima* is a highly specialised larva it is, in a certain sense, embryonic, for the fully grown *Alima* closely resembles the young *Lysioerichthus* larva, as may be seen by comparing fig. 4 of Pl. I. with fig. 5 of Pl. XII. The *Erichthus*, in some cases and probably always, hatches from the egg as an *Erichthoidina*, while it is probable that all the *Alimæ* leave the egg in the *Alima* stage; but this is so similar to the young *Erichthus* that Claus was disposed to regard his *Erichthus multispinosus* as an *Alima*, although the fully grown *Erichthus* is very different from the *Alima* at any stage of its development. Apparently the stage which the *Lysioerichthus* passes through, immediately after the *Erichthoidina* stage, has proved to be so well adapted to the needs of the *Squilla* larva that it has been lengthened at both ends of the larval life until both the initial *Erichthoidina* stage and the final *Squillerichthus* stage have been crowded out of its larval life, and the *Alima* hatches as an *Alima* and remains an *Alima* until it changes into a *Squilla*.

The relation between the metamorphosis of *Lysiosquilla* and that of *Squilla* is therefore something like this—




*Squilla nepa*, Latreille.

The Challenger collection includes ten specimens of this species: seven of them, five of which are males and two females, from Pokoska, Japan, captured in the trawl in from 5 to 25 fathoms of water; one male specimen from Kobé, Japan, in 8 to 50 fathoms; one female specimen from the Reefs at Honolulu; and one female specimen taken in the trawl at Station 233B, Inland Sea, Japan; May 26, 1875, lat. 34° 18′ N., long. 133° 35′ E.; 15 fathoms; bottom, blue mud.

The tip of the first abdominal appendage of an adult male, *Squilla empusa*, is shown in Pl. II. fig. 7; and that of *Squilla nepa* is almost the same.

*Measurements.*

| | |
|---|---|
| No. 1, Large male. | No. 4, Smaller male. |
| No. 2, Male a little smaller. | No. 5, Large female. |
| No. 3, Small male. | |

| Measurements. | In inches and decimals. | | | | | In thousandths of total length. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
| Total length from tip of rostrum to tip of telson, | 5·48 | 5·05 | 4·26 | 2·56 | 5·53 | ... | ... | ... | ... | ... |
| Rostrum, | ·14 | ·14 | ·13 | ·09 | ·14 | ·026 | ·028 | ·031 | ·35 | ·026 |
| Carapace, | 1·18 | 1·13 | ·97 | ·53 | 1·17 | ·215 | ·223 | ·228 | ·207 | ·219 |
| Carapace including rostrum, | 1·32 | 1·27 | 1·10 | ·62 | 1·31 | ·241 | 2·51 | ·259 | ·242 | ·245 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·20 | ·16 | ·13 | ·10 | ·20 | ·056 | ·032 | ·031 | ·040 | ·037 |
| From posterior edge of second thoracic to posterior edge of third thoracic somite, | ·20 | ·17 | ·13 | ·10 | ·20 | ·056 | ·034 | ·031 | ·040 | ·037 |
| From posterior edge of third thoracic to posterior edge of fourth thoracic somite, | ·26 | ·20 | ·18 | ·12 | ·24 | ·067 | ·040 | ·042 | ·048 | ·035 |
| From posterior edge of fourth thoracic to posterior edge of fifth thoracic somite, | ·26 | ·20 | ·18 | ·12 | ·24 | ·067 | ·039 | ·042 | ·048 | ·035 |
| First abdominal somite, | ·43 | ·37 | ·27 | ·20 | ·45 | ·078 | ·073 | ·065 | ·079 | ·085 |
| Second abdominal somite, | ·36 | ·36 | ·27 | ·20 | ·40 | ·066 | ·071 | ·065 | ·079 | ·075 |
| Third abdominal somite, | ·36 | ·36 | ·27 | ·18 | ·40 | ·066 | ·070 | ·065 | ·070 | ·075 |
| Fourth abdominal somite, | ·38 | ·36 | ·31 | ·16 | ·43 | ·069 | ·070 | ·073 | ·064 | ·080 |
| Fifth abdominal somite, | ·50 | ·42 | ·35 | ·22 | ·47 | ·091 | ·082 | ·082 | ·070 | ·088 |
| Sixth abdominal somite, | ·36 | ·34 | ·28 | ·16 | ·31 | ·066 | ·066 | ·066 | ·064 | ·058 |
| Telson on middle line, | ·85 | ·84 | ·79 | ·38 | ·88 | ·155 | ·184 | ·186 | ·160 | ·165 |
| Total length of hind body, | 4·16 | 3·78 | 3·16 | 1·94 | 4·22 | ·837 | ·761 | ·748 | ·762 | ·770 |
| Total length on middle line from tip of rostrum to tip of telson, | 5·48 | 5·05 | 4·26 | 2·56 | 5·53 | 1·078 | 1·012 | 1·007 | 1·004 | 1·015 |
| Greatest length of telson, | 1·08 | ·96 | ·92 | ·46 | 1·12 | ·199 | ·190 | ·216 | ·179 | ·207 |
| Width of carapace at antero-lateral angle, | ·62 | ·57 | ·52 | ·28 | ·64 | ·113 | ·114 | ·122 | ·109 | ·120 |
| Width of carapace at postero-lateral angle, | ·96 | ·90 | ·84 | ·44 | 1·00 | ·175 | ·180 | ·197 | ·172 | ·187 |
| Width of second thoracic somite, | ·92 | ·82 | ·76 | ... | ·90 | ·168 | ·164 | ·178 | ... | ·168 |
| Width of third thoracic somite, | ·97 | ·88 | ·74 | ... | ·96 | ·177 | ·176 | ·174 | ... | ·184 |
| Width of fourth thoracic somite, | ·98 | ·92 | ·78 | ·45 | 1·00 | ·179 | ·194 | ·183 | ·176 | ·187 |
| Width of fifth thoracic somite, | ·92 | ·90 | ·76 | ... | ·92 | ·168 | ·180 | ·178 | ... | ·172 |
| Width of first abdominal somite, | 1·12 | 1·05 | ·89 | ·50 | 1·20 | ·204 | ·210 | ·209 | ·195 | ·224 |
| Width of second abdominal somite, | 1·20 | ... | ... | ... | 1·21 | ·219 | ... | ... | ... | ·233 |
| Width of third abdominal somite, | 1·22 | ... | ... | ... | 1·24 | ·223 | ... | ... | ... | ·233 |
| Width of fourth abdominal somite, | 1·24 | ... | ... | ... | 1·25 | ·226 | ... | ... | ... | ·224 |
| Width of fifth abdominal somite, | 1·24 | 1·20 | 1·02 | ·59 | 1·26 | ·226 | ·238 | ·240 | ·231 | ·226 |
| Width of sixth abdominal somite, | 1·10 | 1·02 | ·88 | ·48 | 1·11 | ·201 | ·202 | ·207 | ·187 | ·208 |
| Width of telson between postero-median spines, | ·32 | ·30 | ·24 | ·12 | ·30 | ·058 | ·059 | ·056 | ·047 | ·056 |
| Width of telson between postero-lateral spines, | ·83 | ·88 | ·80 | ·30 | ·90 | ·151 | ·174 | ·188 | ·117 | ·168 |
| Width of telson (greatest), | 1·10 | 1·04 | ·90 | ·49 | 1·10 | ·201 | ·206 | ·211 | ·191 | ·206 |
| Total length of first antenna, | 2·40 | 2·40 | ... | ... | 1·80 | ·438 | ·475 | ... | ... | ·336 |
| Length of scale of second antenna, | ·84 | ·74 | ·66 | ·38 | ... | ·153 | ·147 | ·155 | ·148 | ... |
| Length of eye, | ·24 | ... | ... | ... | ·24 | ·044 | ... | ... | ... | ·045 |
| Width of eye, | ·30 | ... | ... | ... | ·25 | ·055 | ... | ... | ... | ·047 |

*Squilla quinquedentata*, n. sp. (Pl. I. fig. 3; Pl. II. fig. 6).

*Diagnosis.*—Dactylus of raptorial claw with five teeth, including terminal one. Free somites of hind body with submedian dorsal carinæ, which are absolute in the four exposed thoracic and the first four abdominal somites, as are also the next pair in the thoracic and first three abdominal somites. Appendages of exposed thoracic legs slender. Lateral margins of first three exposed thoracic somites bilobed.

*General Description.*—Rostral plate nearly rectangular, a little longer than wide, with antero-lateral angles rounded, and lateral edges raised into ridges or marginal

carinæ which are continued forwards as far as the rounded angles. Between these marginal ridges the dorsal surface of the rostrum is smooth, without a median carina, with the posterior half pigmented (in the alcoholic specimen) and separated by a semicircular line, convex in front, from the anterior colourless half. Antero-lateral angles of carapace ending in very short acute spines; postero-lateral angles rounded and not prominent, and without a marginal notch. The carapace has a median longitudinal carina which is very slightly raised, although its dark colour renders it conspicuous. It is bifurcated at its anterior end and is interrupted at the transverse cervical suture, behind which it is bifurcated to its posterior end, where the two divisions meet in a round median tubercle on the posterior edge of the carapace. A lateral carina, marked with dark pigment, runs from the antero-lateral spine on each side nearly parallel to and close to the lateral edge of the carapace, as far as the postero-lateral angle, on which it ends abruptly, without uniting with the transverse pigmented ridge which fringes the posterior border of the carapace.

A second pigmented carina runs backwards from the antero-lateral angle for about half the length of the carapace, internal to the submarginal keel, and nearer to it anteriorly than posteriorly. At its posterior end it is about half way between the edge of the carapace and a strongly marked convex ridge which lies in the longitudinal gastric suture, between the elevated convex median gastric area and the lateral area. The gastric sutures and their ridges are slightly divergent posteriorly, and they are interrupted at the transverse cervical suture, behind which the cardiac sutures are marked by similar elevated ridges, which are slightly incurved at their anterior ends, behind which they are slightly convergent posteriorly. External to the cardiac sutures there is, on each side, a short pigmented carina, which fuses with the pigmented border of the posterior edge of the carapace, which latter is slightly emarginated, with a short acute median tooth.

The second, third, and fourth thoracic somites have each a median slightly impressed white line, and on the sides of this a pair of pigmented submedian longitudinal carinæ, which are very short on the second, and which are clearly marked by their dark colour, but are scarcely elevated above the general surface. The fifth thoracic somite has no impressed median line, and the submedian carinæ are like those on the preceding somite. The submarginal carinæ of the thoracic somites are scarcely elevated, and they are marked by dark pigment, as are also the posterior borders of all the thoracic and abdominal somites. The lateral processes of the second, third, and fourth thoracic somites are bilobed; the anterior lobe of the first is elongated, curved forwards and acute, while the posterior lobe is much shorter and subacute. On the lateral process of the third thoracic somite the anterior lobe is shorter and subacute, and on the fourth somite it is still shorter, while in both the third and the fourth somites the posterior lobe is the larger, and its postero-lateral angle is acute on the third, and subacute on the fourth. The fifth thoracic somite has only a single subacute lobe on each side. The first five

abdominal somites have eight keels each, including the marginal ones, and the sixth abdominal somite has six. In all the abdominal somites the postero-lateral angles end acutely in spines, as do the posterior ends of all the keels on the sixth and fifth, and all except the submedians of the fourth. There are no median keels between the carapace and the telson, but the third, fourth, and fifth abdominal somites have median tubercles. The submedian keels of the fifth abdominal somite diverge posteriorly, while all the keels of the sixth abdominal somite converge posteriorly. The first lateral keels of the first, second, and third abdominal somites are slightly sinuous. The telson has a very prominent median dorsal carina, which is situated upon the middle line of an elongated convex protuberance. The carina ends posteriorly in a prominent acute spine, and it is bordered by dark pigment at each end and in the middle. The margin of the telson carries six acute spines, with a short dorsal carina running forwards from the base of each of them, and a similar carina, without a spine, on the anterior portion of the lateral margin. The submedian spines are straight, the intermediate curved, and the externals curved and very short. There is a single rounded lobe or tooth between the base of the external spine and the base of the intermediate spine on each side, and eight on each side between the base of the intermediate spine and the base of the submedian, and six between the submedians, three of them on each side of the deep median notch, which is closed behind and converted into a foramen in the single specimen which was obtained. On each side of the broad median longitudinal ridge the dorsal surface of the telson is marked by shallow pits symmetrically arranged in curved lines, running outwards and backwards from the median ridge to the notches between the rounded lobes on the posterior border of the telson. The ventral prolongation from the basal joint of the uropod ends in a short curved outer branch, and a much stouter and longer inner branch which carries a blunt rounded tooth on its outer edge about half way between the base and the tip, and a number of irregular serrations along its inner edge.

The outer edge of the second joint of the exopodite of the uropod is fringed by a series of seven movable spines, the first six of which increase regularly in size towards the tip, while the seventh is much larger than the sixth, and is terminal. The eye is broadly triangular, and its length from its union with the short stalk to the rounded posterior angle of the cornea is about equal to its width between the two rounded angles of the cornea, which is divided into two halves by a transverse vertical furrow. The ocular somite is exposed on the middle line. The dactylus of the raptorial second maxilliped is divided into five curved acute teeth, and the keel on the anterior edge of the third or carpal joint is smooth and entire.

The movable ramus *f* (Pl. II. fig. 6) of the forceps on the first abdominal appendage of the male is very large, and four times as long as the fixed ramus, which is bent into a single hook at its tip.

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tip of rostrum to tip of median spine of telson, | 5·37 | ... |
| Measurements along middle line:— | | |
| Rostrum, | ·16 | 30 |
| Carapace, | 1·28 | 238 |
| Total length of rostrum and carapace, | 1·44 | 268 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·13 | 24 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·24 | 45 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·22 | 41 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·24 | 45 |
| First abdominal somite, | ·40 | 74 |
| Second abdominal somite, | ·36 | 67 |
| Third abdominal somite, | ·36 | 67 |
| Fourth abdominal somite, | ·40 | 75 |
| Fifth abdominal somite, | ·50 | 93 |
| Sixth abdominal somite, | ·34 | 63 |
| Telson on middle line, | ·74 | 138 |
| Total length of hind body, | 3·93 | 732 |
| Total length on middle line, | 5·37 | 1000 |
| Greatest length of telson, | ·96 | 179 |
| Width of carapace between antero-lateral spines, | ·58 | 98 |
| Greatest width of carapace, | ·94 | 175 |
| Width of second thoracic somite, | ·88 | 164 |
| Width of third thoracic somite, | ·90 | 168 |
| Width of fourth thoracic somite, | ·92 | 171 |
| Width of fifth thoracic somite, | ·92 | 171 |
| Width of first abdominal somite, | 1·08 | 201 |
| Width of second abdominal somite, | 1·16 | 216 |
| Width of third abdominal somite, | 1·16 | 214 |
| Width of fourth abdominal somite, | 1·16 | 216 |
| Width of fifth abdominal somite, | 1·16 | 216 |
| Width of sixth abdominal somite, | ·98 | 183 |
| Width of telson between postero-median spines, | ·22 | 41 |
| Width of telson between postero-lateral spines, | ·82 | 153 |
| Width of telson (greatest), | 1·04 | 194 |
| Length of first antenna (shaft), | 1·00 | 189 |
| Length of first antenna (flagellum), | ·90 | 168 |
| Length of first antenna (total), | 1·90 | 357 |
| Length of flagellum of second antenna, including shaft, | ·96 | 179 |
| Length of scale of second antenna, | ·88 | 164 |
| Length of eye, | ·20 | 37 |
| Width of eye, | ·23 | 43 |

*Habitat.*—Station 188, September 10, 1874, Arafura Sea; lat. 9° 59′ S., long. 139° 42′ E.; depth, 28 fathoms; bottom, green mud. A single male specimen.

*Remarks.*—Notwithstanding the fact that it has five teeth instead of six on the dactylus of the raptorial claw, and the very slight development of the longitudinal carinæ on the hind body, this species bears such a very close general resemblance to the well known *Squilla nepa*, that I was at first inclined to regard it as a smooth specimen of this species, with an accidental variation in the number of teeth on the dactylus, and the more especially as *Squilla nepa* is known to occur in the region where the specimen was obtained. More careful examination, however, reveals so many minute points of difference in all parts of the body that I think there can be no doubt of its distinctness. The following, which are the most conspicuous differences, will serve to distinguish it with readiness from the latter species. *Squilla nepa* has six and *Squilla quinquedentata* five spines, including the terminal one, on the dactylus of the raptorial claw. The carinæ on the anterior edge of the third joint or carpus of the raptorial claw of *Squilla nepa* is irregularly dentated, while it is entire and smooth in *Squilla quinquedentata*. The rostrum of *Squilla nepa* narrows slightly towards the tip, while that of *Squilla quinquedentata* is more nearly rectangular. The longitudinal cardiac sutures on the posterior portion of the carapace are divergent posteriorly in *Squilla nepa*, and convergent in *Squilla quinquedentata*. The submedian carinæ of the fifth abdominal somite are parallel in *Squilla nepa*, and divergent posteriorly in *Squilla quinquedentata*.

*Squilla leptosquilla*, n. sp. (Pl. I. figs. 1, 2).

*Diagnosis.*—Ocular segment in front of rostrum. Eyes broad and sub-triangular. Exposed segments of hind body with submedian carinæ. Dactylus of raptorial claw with four spines, including the terminal one. Antennulary somite very long, reaching to tip of rostrum on middle line, and with its antero-lateral angles prolonged forwards into acute spines. First thoracic somite partially exposed dorsally. Lateral margins of second, third, and fourth thoracic somites acute. Telson with a long slender median spine on dorsal surface, and three pairs of marginal spines, of which the second or intermediate pair are much the longest, and the external pair shorter than the submedians, and blunt, while the others are acute. First antennæ very long.

*General Description.*—Rostrum nearly twice as long as wide, subtriangular, with a rounded anterior end. Width of carapace between antero-lateral angles about $\frac{9}{14}$ of its greatest width, which is equal to about two-thirds ($\frac{14}{20}$) of its length. The length of the carapace is $\frac{209}{1000}$ of the total length of the body, and its antero-lateral angles are produced forwards as long acute spines, while the postero-lateral angles are prominent and broadly rounded. The gastric area of the carapace is convex and elevated, with an obscure

median carina, which is continued forwards on to the rostrum, and is interrupted behind by the strongly marked cervical sutures, posterior to which the median carina is continued to the posterior edge of the carapace, where there is no median tubercle. There are two longitudinal carinæ on each lateral portion of the carapace, a submarginal one, which lies near the base of the antero-lateral spine, along nearly the whole length of the carapace parallel to and near the thickened lateral margin, and a second or internal one, which lies about midway between the first and the gastric suture, and comes to an end in front of the transverse cervical suture. The thickened ridge which borders the lateral margin of the carapace and the rounded postero-lateral lobe bends inwards around the posterior margin of the latter, and running forwards on the dorsal surface of the carapace, forms a submedian carinæ parallel to and just outside the cardiac suture, and extending forwards as far as the transverse cervical suture. The posterior edge of the carapace, which does not completely cover the first thoracic somite, is nearly transverse.

The second, third, fourth, and fifth thoracic somites have each four longitudinal dorsal carinæ, the submedian on the second being very short and concave towards the middle line; the first five abdominal somites have each six longitudinal carinæ besides the marginal ones, and the sixth somite six in all, which all end posteriorly in acute spines, while there are no spines on the submedians of the thoracic and first five abdominal somites, nor on the first lateral carinæ of the thoracic and first abdominal.

The marginals and submarginals of the first five abdominal somites, and the intermediates of all except the first abdominal, end in spines. The submedian dorsal carinæ are parallel in the first eight exposed somites, divergent posteriorly in the fifth abdominal somite, and convergent posteriorly in the sixth abdominal somite. While the somites increase slightly in width from in front backwards the space included between the second pair of carinæ is of uniform width from the second thoracic to the fifth abdominal somite, and these carinæ form the prominent parallel ridges running along the whole length of the abdomen, although the carina itself is interrupted by a notch near the anterior edge of each abdominal somite except the sixth. The second, third, fourth, and fifth abdominal somites have each a median dorsal double tubercle. The lateral processes of the thoracic somites are much like those of *Squilla mantis*. The lateral margin of the second is prolonged with a long straight acute lobe, while the third and fourth are obliquely truncated, the third more obliquely than the fourth, and end behind in acute points. The fifth is furnished at its antero-lateral angle with a small subacute process or tooth. The telson ends in six marginal spines, of which the submedians are acute and triangular, the intermediates very long, curved, slender, and acute, and about twice as long as the submedians, and the laterals very short, about half the length of the submedians, rounded and subacute. The tips of the long median spines are in the same transverse line with the tips of the submedians, while their bases are in the same transverse line with the base of the unpaired median spine. There is a single rounded dentation between the

base of the lateral spine and the base of the intermediate, and between the base of the intermediate and the tip of the submedian eleven or twelve small acute serrations, while there are about the same number of similar but much smaller serrations between the tip of the submedian spine and the middle line. The dorsal surface of the telson has a median longitudinal ridge which ends behind in a long slender acute spine. On each side of the ridge there is a longitudinal row of five or six shallow circular pits, from each one of which a faintly marked curved line runs outwards and backwards to the posterior margin. The endopodite of the uropod is long, slender, curved, and about eight times as long as wide, and the elongated oval paddle of the exopodite is about equal in length to the second joint. The ventral prolongation from the posterior edge of the basal joint ends in two slender acute curved spines, of which the inner is much (about $\frac{3}{2}$) longer than the outer, with a small tooth on its outer, and a series of minute serrations on its inner edge.

The eyes are broadly subtriangular, and the distance from the rounded posterior angle of the cornea to the point where the eye joins the constricted stalk is equal to the distance between the angles of the cornea, which latter is divided into two nearly equal lobes by a vertical groove. The ocular somite lies entirely in front of the rostrum. The first antenna has a very long slender shaft, and its total length to the tip of the internal or longest flagellum is a little more than half ($\frac{55}{100}$) the total length of the body from the tip of the rostrum to the tip of the telson. The anterior edge of the somite which carries the first antennæ is under the tip of the rostrum, and its antero-lateral angles are produced forwards as slender acute spines. The raptorial second maxilliped is long, and its dactylus has on its inner edge four spines, including the terminal one, which are acute, curved, and gradually increasing in size distally. On the outer edge of the dactylus near the base there is a small process. The three pairs of exposed thoracic legs are short and slender, and their appendages are filiform. The endopodite of the first abdominal appendage of the male (Pl. I. fig. 2) is elongated and nearly rectangular, and the inner edge is straight. The outer lobe *a* of the terminal joint is much shorter than the inner lobe *b*, which is separated from it by a suture. The fixed limb of the petasma *e* is very long, reaching nearly to the tip of the inner lobe, and its tip carries on its inner edge two hooks or lobes, one of which points towards the tip and the other towards the base of the appendage.

*Habitat.*—The Challenger collection includes only one specimen, a male, from Station 204B, lat. 12° 46′ N., long. 122° 10′ E., in the Celebes Sea, near the Philippine Islands, taken with the trawl from a depth of 115 fathoms; bottom, green mud.

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| On middle line :— | | |
| Rostrum, | ·10 | 36 |
| Carapace, | ·58 | 209 |
| Carapace, including rostrum, | ·68 | 245 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·10 | 36 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·13 | 47 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·13 | 46 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·14 | 50 |
| First abdominal somite, | ·20 | 72 |
| Second abdominal somite, | ·20 | 72 |
| Third abdominal somite, | ·20 | 72 |
| Fourth abdominal somite, | ·18 | 65 |
| Fifth abdominal somite, | ·25 | 90 |
| Sixth abdominal somite, | ·13 | 43 |
| Telson on middle line, | ·34 | 158 |
| Total length of hind body, | 2·00 | 635 |
| Total length on middle line, | 2·68 | 1000 |
| Greatest length of telson, | ·44 | 158 |
| Width of carapace between antero-lateral angles, | ·24 | 86 |
| Width of carapace (greatest), | ·39 | 140 |
| Width of second thoracic somite, | ·41 | 147 |
| Width of third thoracic somite, | ·41 | 147 |
| Width of fourth thoracic somite, | ·41 | 147 |
| Width of fifth thoracic somite, | ·40 | 144 |
| Width of first abdominal somite, | ·52 | 187 |
| Width of second abdominal somite, | ·54 | 194 |
| Width of third abdominal somite, | ·55 | 198 |
| Width of fourth abdominal somite, | ·56 | 201 |
| Width of fifth abdominal somite, | ·56 | 201 |
| Width of sixth abdominal somite, | ... | ... |
| Width of telson between submedian terminal spines, | ·13 | 46 |
| Width of telson between intermediate terminal spines, | ·37 | 133 |
| Width of eyes between angles of cornea, | ·13 | 46 |
| Length of eyes, | ·13 | 46 |
| Length of basal joint of first antenna, | ·22 | 79 |
| Length of second joint of first antenna, | ·26 | 94 |
| Length of third joint of first antenna, | ·23 | 83 |
| Length of flagellum of first antenna, | ·75 | 296 |
| Length of flagellum of second antenna, | ·61 | 222 |
| Length of scale of second antenna, | ·50 | 180 |
| Length of somite of first antenna, | ·14 | 50 |
| Length of labrum, | ·36 | 129 |

*Remarks.*—This species differs from *Squilla miles*, Hess., in the presence of acute spines on the antero-lateral angles of the carapace, and in the absence of triangular

processes on the four somites of the hind body, and of movable spinules on the submedian spines of the telson. It differs from Mier's genus *Leptosquilla* in the enlargement of the tips of the eyes, and in the presence of distinct submedian carinæ on all the five somites of the hind body.

*Squilla lata*, n. sp. (Pl. III. figs. 1, 2, 3).

*Diagnosis.*—The dactylus of the raptorial limb has six teeth, and the pectinations on the inner edge of the second joint are arranged in an undulating line. Eyes directed forward, nearly cylindrical, with corneal portion hardly wider than base. Appendages of exposed thoracic limbs strap-shaped. Hind body gradually increasing in width backwards to the fifth abdominal somite, which is equal in breadth to one-fourth of the total length. Inner spine of basal joint of sixth abdominal appendage with a rounded tooth on its outer edge, and, on its inner edge, a series of acute dentations gradually increasing in length distally. Rostrum elongated, nearly twice as long as wide. Submedian dorsal carinæ absent on the first and second thoracic and second and third abdominal somites, and obsolete on all the others except the sixth abdominal, where they are well developed. Submedian spines of telson curved at their tips; and flattened, broad and rounded at their bases, with no intermediate dentations. Dorsal surface of telson obscurely marked by curved lines. Paddle of exopodite of sixth abdominal appendage as long as second joint. There is no spine on the dorsal surface of the basal joint of the sixth abdominal appendage. Lateral edges of second thoracic somite acute, those of the third and fourth obliquely truncated.

*Special Description.*—Rostrum twice as long as broad, and ending in a rounded point. Antero-lateral angles of carapace acute, posterior angles rounded, anterior border subacute, posterior border nearly transverse. No median carina on rostrum or carapace, the gastric area of which is only slightly convex. On each side of carapace there is a carina which reaches nearly to the cervical suture, behind which there is a short carina on each postero-lateral lobe. A median dorsal tubercle close to the posterior edge of the carapace. Length of rostrum $\frac{47}{1000}$, and of carapace $\frac{295}{1000}$, and of the two $\frac{252}{1000}$ of the total length. Hind body gradually and uniformly increasing in width from in front backwards to the fifth abdominal somite, which is more than twice ($\frac{251}{166}$) as wide as the second thoracic somite. The second thoracic somite has no dorsal carinæ; the third has one lateral carina on each side, but no submedians; the fourth and fifth thoracic somites have very obscure and short median carinæ which converge anteriorly, as well as lateral carinæ. The first five abdominal somites have three lateral carinæ on each side. The first three have no submedian carinæ, while there are short obsolete submedian carinæ on the fourth and fifth, converging anteriorly. The third, fourth, and fifth abdominal somites have each a median dorsal tubercle. The sixth abdominal somite has two well marked sub-

medians and two pairs of lateral ones, all six ending in spines, while none of the other carinæ end in spines. The telson has a broad convex median dorsal ridge which ends behind in a short acute spine, and on each lateral portion there are six obsolete symmetrical curved lines. The posterior border of the telson carries six lobes or teeth, the laterals and postero-laterals acute and straight, while the acute points of the submedians are curved inwards. There is a single rounded lobe between the lateral and the postero-lateral, six between the postero-lateral and postero-median, and none between the postero-medians, the space being filled up by the flattened bases of the spines which meet on the middle line. The sixth abdominal appendage is very large, and the terminal paddle of the exopodite is oval and equal in length to the proximal joint. The endopodite is long, curved, and narrow, and the prolongation from the lower surface of the basal joint ends in a short curved acute outer spine, and a much longer inner spine, which has a rounded tooth on its outer border and on its inner border six or seven acute teeth which increase in size distally. There is no dorsal spine on the basal joint.

The ocular segment is wholly anterior to the long rostrum, and the eyes are directed forwards side by side, and are twice as long as wide and swollen in the middle, although the retinal portion, which is divided by a depression into halves, is a little wider than the base. The first antennæ are short ($\frac{29}{100}$ of the total length) and their somite ends dorsally in a pair of lateral spines which point forward. The flagellum of the second antenna, including the three-jointed shaft, is nearly ($\frac{23}{28}$) as long as the first, and the scale is $\frac{11}{100}$ as long as the animal.

The width of the carapace between the antero-lateral spines is about half ($\frac{10}{18}$) its greatest width, and almost exactly half its length. The dactylus of the raptorial claw of the second maxilliped is armed with six curved acute teeth, gradually increasing in size distally. The second joint has three movable spines on its inner edge, and the pectinations of its outer edge are arranged in an undulating line, with a convexity under each tooth of the dactylus (see fig. 2 Pl. III.). The appendages of the three pairs of exposed thoracic legs are flat, strap-shaped, and dilated at the tips. The lateral edges of the second thoracic somite are acute and a little curved forward, and those of the third and fourth somites are obliquely truncated, with subacute anterior and posterior angles. The fifth has no angular process. Sexes alike.

*Habitat.*—Station 190, in the Arafura Sea, south of New Guinea, September 12, 1874; lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; two males and one female taken in the trawl.

*Remarks.*—This and the following species, *Squilla fasciata*, closely resemble the genus *Chloridella* in the shape of the eyes, and in the flattened strap-like form of the appendages to the exposed thoracic limbs. They agree in many points, as will be shown in the description of the second species, but there are so many well-marked differences that there can be no doubt of their distinctness.

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tips of eyes to tips of spines of telson, | 3·500 | |
| On middle line :— | | |
| From tip of rostrum to tip of telson, | 3·225 | 1000 |
| Rostrum, | ·150 | ·47 |
| Carapace, | ·660 | 205 |
| Carapace, including rostrum, | ·810 | 252 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·070 | 22 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·145 | 45 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·125 | 39 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·145 | 45 |
| First abdominal somite, | ·255 | 79 |
| Second abdominal somite, | ·215 | 67 |
| Third abdominal somite, | ·220 | 68 |
| Fourth abdominal somite, | ·220 | 68 |
| Fifth abdominal somite, | ·280 | 87 |
| Sixth abdominal somite, | ·230 | 71 |
| Telson on middle line, | ·510 | 158 |
| Length of free somites, | 2·415 | 749 |
| Total length on middle line, | 3·225 | 1000 |
| Length of telson to tips of spines, | ·620 | 192 |
| Width of carapace between antero-lateral spines, | ·340 | 105 |
| Width of carapace (greatest), | ·585 | 181 |
| Width of second thoracic somite, | ·495 | 153 |
| Width of third thoracic somite, | ·535 | 166 |
| Width of fourth thoracic somite, | ·595 | 184 |
| Width of fifth thoracic somite, | ·585 | 181 |
| Width of first abdominal somite, | ·740 | 229 |
| Width of second abdominal somite, | ·780 | 242 |
| Width of third abdominal somite, | ·805 | 250 |
| Width of fourth abdominal somite, | ·810 | 251 |
| Width of fifth abdominal somite, | ·810 | 251 |
| Width of sixth abdominal somite, | ·690 | 217 |
| Width of telson between postero-median spines, | ·130 | 40 |
| Width of telson between postero-lateral spines, | ·470 | 146 |
| Width of telson (greatest), | ·635 | 197 |
| Total length of sixth abdominal appendage, | ·426 | 132 |
| Distance between tips of abdominal appendages, | 1·600 | 496 |
| Length of paddle of exopodite of sixth abdominal appendage, | ·265 | 82 |
| Length of base of exopodite of sixth abdominal appendage, | ·265 | 82 |
| Length of endopodite of sixth abdominal appendage, | ·408 | 126 |
| Length of eye, | ·135 | 42 |
| Width of eye, | ·095 | 29 |
| Length of first antenna, measured from tip of rostrum, | ·925 | 287 |
| Length of flagellum of second antenna, | ·770 | 239 |
| Length of scale of second antenna, | ·360 | 112 |
| Distance from tip of rostrum to cervical suture, on middle line, | ·675 | 209 |

In its general characteristics this species conforms pretty exactly to Mier's description of *Squilla dubia* of Milne-Edwards (*Squilla rubrolineata*, Dana and v. Martens), but it may readily be distinguished from this species, which is recorded only from the western shore of the Atlantic, by the absence of submedian carinæ on most of the free somites, and by the absence of dentations between the submedian spines of the telson.

*Squilla fasciata*, De Haan (Pl. III. figs. 4, 5 ; Pl. II. fig. 8).

*Squilla fasciata*, De Haan, Fauna Japon., Crustacea, p. 224, p. 2, 2*i*, fig. 4, 1849.
*Squilla fasciata*, Miers, Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 29, 1880.

*Diagnosis.*—Six teeth on dactylus of raptorial claw. Dentations on inner edge undulating. Eyes directed forward, nearly cylindrical, with conical portion hardly wider than the base. Appendages of exposed thoracic limbs strap-shaped. Hind body gradually increasing in width from in front backwards to the fifth abdominal somite, which is equal in breadth to more than one-fourth of the total length. Inner spine of basal joint of sixth abdominal appendage longer than outer, with a rounded tooth on its outer and on its inner edge a series of acute dentations gradually increasing in length distally. Rostrum only a little longer than wide. Submedian dorsal carinæ entirely absent in all the exposed somites of the hind body except the sixth abdominal. Submedian spines of telson acute, with about eight intermediate acute dentations. Dorsal surface of telson with four or five sharply defined longitudinal carinæ on each side of the median ridge. Paddle of exopodite of sixth abdominal appendage about half as long as second joint, and an acute spine on the dorsal surface of the basal joint of the appendage. Lateral edges of second thoracic somite acute, those of the third and fourth rounded.

*Special Description.*—Rostrum only a little longer than wide, subtriangular, with a broadly rounded tip. Antero-lateral angles of carapace acute; postero-lateral angles rounded; anterior border nearly transverse; posterior border deeply notched on middle line. No median carina on the rostrum or on the carapace, the gastric area of which is conspicuously convex. Lateral carinæ of carapace very faintly indicated. No median dorsal tubercle on posterior edge of carapace. Length of rostrum $\frac{42}{1000}$, and of the carapace $\frac{231}{1000}$, and of the two $\frac{273}{1000}$ of the total length. Hind body gradually and uniformly increasing in width from in front backwards to the fifth abdominal somite, which is one and one-half times as broad as the second thoracic somite. There are no submedian dorsal carinæ on any of the exposed somites of the hind body except the sixth abdominal; the second thoracic somite has no dorsal carinæ. The third, fourth, and fifth have each a pair of lateral carinæ, and the first five abdominal somites have each three pairs of lateral carinæ, including the marginal ones; all of which, except the inner ones of the first abdominal somite, end in spines. The sixth abdominal somite has well-marked submedian carinæ converging posteriorly, and two pairs of lateral ones, all six

ending in spines. The telson has a broad convex median dorsal ridge which ends behind in a short acute spine, and on each lateral portion there are four or five sharply defined parallel longitudinal carinæ. The posterior border of the telson has three pairs of acute straight spines, and there is a single rounded tooth between the lateral and postero-lateral, eight acute curved teeth between the latter and the submedian, and four between this and the middle line, which is deeply notched. The sixth abdominal appendage is very large, and the terminal paddle of the exopodite is oval and half as long as the proximal joint. The endopodite is long, narrow, and very slightly curved, and the prolongation from the ventral surface of the basal joint ends in a short curved acute outer spine, and a much longer acute inner spine which has a rounded tooth on its outer border, and on its inner border seven or eight acute teeth which increase in size distally. There is an acute spine on the dorsal surface of the basal joint.

The rostrum reaches to the base of the ocular segment, and the eyes are directed forward, side by side, and nearly cylindrical and about twice as long as wide. The first antennæ are long ($\frac{4}{10}$ of the total length of the body), and their somite ends dorsally in a pair of acute spines which are slightly divergent. The flagellum of the second antenna, including the shaft, is about three-fourths ($\frac{23}{40}$) as long as the first, and the scale is $\frac{17}{100}$ as long as the animal. The width of the carapace between the antero-lateral angles is half ($\frac{19}{20}$) its greatest width and a little less than half ($\frac{19}{23}$) its length. The dactyle of the raptorial claw is armed with six acute curved teeth gradually increasing in size distally. The second joint has three movable spines on its inner edge, and the pectinations on its inner edge are arranged in an undulating line, with a convexity under each tooth. The appendages of the three pairs of exposed thoracic limbs are flat, strap-shaped and more dilated and rounded at the tip than they are in *Squilla lata*. The lateral edges of the second thoracic somite are acute, and strongly curved forward, while the lateral edges of the third and fourth are rounded. The fifth has a subacute prominence on each side. Males and females alike, except as regards the structures concerned in reproduction.

*Habitat.*—Station 233B, Inland Sea, Japan, May 26, 1875; lat. 34° 18′ N., long. 133° 35′ E.; depth 15 fathoms; bottom blue mud.

Two specimens, a male and a female, were obtained. The only other specimen known is also from Japan, and is described by De Haan as the type of the species.

*Remarks.*—This species is very similar to the one last described, agreeing with it in the presence of six teeth in the raptorial claw, the cylindrical shape of the eyes, the almost total absence of median and submedian dorsal carinæ, the great width and the uniform increase in width of the hind body, the flattened strap-like shape of the appendages of the exposed thoracic legs, the great length of the curved endopodite of the sixth abdominal appendage, and the presence of acute teeth on the inner margin of its inner spine. There are so many well-marked points of difference, however, that there can be

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tip of rostrum to tip of telson, | 1·806 | |
| Measurements along the middle line :— | | |
| Rostrum, | ·075 | 42 |
| Carapace, | ·417 | 231 |
| Total length of carapace, including rostrum, | ·492 | 273 |
| From posterior margin of carapace to posterior edge of second thoracic somite, | ·093 | 52 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·066 | 37 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·060 | 31 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·078 | 43 |
| First abdominal somite, | ·099 | 55 |
| Second abdominal somite, | ·099 | 55 |
| Third abdominal somite, | ·099 | 55 |
| Fourth abdominal somite, | ·099 | 55 |
| Fifth abdominal somite, | ·150 | 83 |
| Sixth abdominal somite, | ·159 | 88 |
| Telson on middle line, | ·312 | 172 |
| Total length of hind body, | 1·314 | 726 |
| Total length on middle line from tip of rostrum, | 1·806 | 999 |
| Greatest length of telson, | ·426 | 236 |
| Width of carapace between antero-lateral spines, | ·186 | 103 |
| Width of carapace (greatest), | ·378 | 209 |
| Width of second thoracic somite, | ·327 | 181 |
| Width of third thoracic somite, | ·291 | 161 |
| Width of fourth thoracic somite, | ·339 | 187 |
| Width of fifth thoracic somite, | ·354 | 194 |
| Width of first abdominal somite, | ·405 | 224 |
| Width of second abdominal somite, | ·438 | 242 |
| Width of third abdominal somite, | ·453 | 250 |
| Width of fourth abdominal somite, | ·501 | 277 |
| Width of fifth abdominal somite, | ·504 | 278 |
| Width of sixth abdominal somite, | ·423 | 246 |
| Width of telson between postero-median spines, | ·117 | 65 |
| Width of telson between postero-lateral spines, | ·306 | 169 |
| Width of telson (greatest), | ·402 | 222 |
| Length of sixth abdominal appendage, | ·597 | 330 |
| Distance from tip of rostrum to end of eye, | ·102 | 56 |
| Distance from tip of rostrum to tip of first antenna, | ·780 | 401 |
| Length of flagellum of second antenna, | ·411 | 227 |
| Length of scale of second antenna, | ·324 | 170 |

no doubt of their specific distinctness, nor of the identity of the second species with the single specimen upon which De Haan based his description of *Squilla fasciata*.

The many differences between the two species are noted in the general description, but they are briefly as follows :—

The species may be readily distinguished by the following features. The rostrum of *Squilla lata* is twice as long as wide, and it gradually tapers to the narrow rounded tip, while it is trigonal in *Squilla fasciata*, hardly longer than wide, with a broad tip. The lateral edges of the third and fourth thoracic somites are obliquely truncated in *Squilla lata*, and rounded in *Squilla fasciata*. The paddle of the exopodite of the sixth abdominal appendage of *Squilla lata* is as long, and that of *Squilla fasciata* half as long, as the second joint. The dorsal surface of the telson of *Squilla lata* is obscurely marked by curved lines, and the submedian posterior spines are curved at the tip and broad at the base, with no intermediate dentations; while the dorsal surface in *Squilla fasciata* is marked by longitudinal carinæ, and the submedian spines are acute with intermediate dentations.

In addition to these more conspicuous points, the following minute differences serve to show the distinctness of the two forms :—

The antennæ are longer than in *Squilla lata;* the carapace is nearly transverse in front and deeply notched behind, while in *Squilla lata* it is subacute in front and nearly transverse behind. All the carinæ of the abdominal somites, except the inner pair on the first, end in spines in *Squilla fasciata*, while in *Squilla lata* only those on the sixth somite end in spines, and there is no dorsal spine on the basal joint of the sixth abdominal appendage, while there is an acute spine in *Squilla fasciata.*

The following measurements in thousandths of the total length also exhibit the difference between the two.

| | Squilla chlorida. | Squilla lata. | Squilla fasciata. |
|---|---|---|---|
| Length of rostrum, | 24 | 47 | 42 |
| Length of carapace, | 196 | 205 | 231 |
| Length of hind body, | 781 | 749 | 726 |
| Width of third thoracic somite, | 168 | 166 | 161 |
| Width of fifth abdominal somite, | 264 | 251 | 278 |
| Length of first antenna, measured from tip of rostrum, | 288 | 287 | 401 |
| Length of flagellum of second antenna, | 232 | 239 | 227 |
| Length of scale of second antenna, | 96 | 112 | 170 |

*Squilla chlorida*, n. sp. (Pl. II. figs. 1–5).

? *Clorida decorata*, Wood-Mason, J. Proc. Asiatic Soc., Bengal, Dec. 1875. On some new species of Stomatopoda Crustacea, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii., 1876, p. 263.

? *Chloridella decorata*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 15, 1880.

*Diagnosis.*—Eyes directed forward, with basal portion swollen, and a little wider than corneal portion. Appendages of thoracic limbs strap-shaped. Five teeth on

dactylus of raptorial claw. All the exposed somites of the hind body with lateral dorsal carinæ, but no submedian dorsal carinæ on any of the exposed somites, except the sixth abdominal. Pectinations on inner edge of second joint of raptorial limb undulating. Width of fifth abdominal somite equal to one-fourth of the total length. Inner spine of basal joint of uropod longer than the outer, with a rounded tooth on its outer edge, and on its inner edge four or five acute teeth gradually increasing in size distally. Rostrum wider than long. Dorsal surface of telson with numerous rounded tubercles on each side of median ridge; ventral surface smooth.

*Special Description.*—Rostrum without a median ridge, a little longer than wide, subtriangular and nearly semicircular. Antero-lateral angles of carapace acute; postero-lateral angles broadly rounded, and prominent; anterior and posterior borders nearly transverse. Carapace without a median carina, and with very faint lines indicating the lateral carinæ; gastric area convex and prominent, with a strongly marked cervical suture. Length of rostrum $\frac{37}{1000}$, and of the carapace $\frac{308}{1000}$, and of the two $\frac{345}{1000}$ of the total length. Exposed thoracic somites increasing gradually in width. First five abdominal somites nearly equal in width, and about equal in width to one-fourth of the total length. The width of the fifth is $\frac{264}{1000}$ of the total length, and it is $\frac{26}{17}$ as wide as the second thoracic somite. There are no submedian dorsal carinæ on any of the exposed somites of the hind body except the sixth abdominal. The first thoracic somite is exposed, and, like the second, has no dorsal carinæ; the third, fourth, and fifth have each a pair of short lateral carinæ, and the first five abdominal somites have each three pairs of lateral carinæ, including the marginal ones, none of which, except those on the sixth abdominal somite, end in spines. The sixth abdominal somite has well-developed submedian, and two pairs of lateral carinæ, all six ending in spines. The first four abdominal somites have each a small median tubercle, which can be detected with difficulty with a lens. The telson has a convex median dorsal ridge, which ends behind in a short acute spine, on each side of which there are numerous scattered rounded tubercles, which obscurely exhibit an arrangement in rows. The ventral surface of the telson is smooth, and the posterior border ends in six pairs of acute spines, with a tuberculated ridge over the base of each postero-median and postero-lateral; a single acute tooth between the lateral and postero-lateral; six or seven acute teeth between each postero-lateral and submedian, and three or four on each side between the tip of the submedian and the deep notch which occupies the middle line. The sixth abdominal appendage is long, and the paddle of the exopodite is oval, about as long as the second joint; the endopodite is long, narrow, and curved; the basal joint carries an acute dorsal spine, and its ventral prolongation ends in a short acute outer spine and a very much longer acute curved inner spine, which has a rounded tooth on its outer margin, and on its inner margin four or five acute curved teeth, which increase in size distally. The rostrum reaches nearly to the base of the ocular somite,

and the eyes are directed forward, side by side, and swollen near the base. The first antennæ are about equal to $\frac{1}{3}$ ($\frac{28}{100}$) of the total length of the body, and their somite ends dorsally in a pair of acute spines which point almost directly forward. The flagellum of the second antenna, including the shaft, is more than $\frac{3}{4}$ ($\frac{23}{28}$) as long as the first, and the scale is only $\frac{1}{10}$ as long as the animal. The width of the carapace between the antero-lateral angles is about half ($\frac{11}{21}$) of its greatest width and about $\frac{1}{3}$ ($\frac{11}{30}$) of its length. The dactylus of the raptorial claw of the second maxilliped is armed with five acute curved teeth, which are finely serrated on their outer edges and increase uniformly in length distally. The second joint has three movable spines on its inner margin, and the pectinations on its outer margin are arranged in an undulating line, with a convexity under each tooth. The appendages of the three pairs of exposed thoracic limbs are strap-shaped and dilated at their tips. The first thoracic somite is entirely exposed dorsally; the second ends laterally in acute spines which are straight and transverse; and the lateral edges of the third and fourth are rounded, with the postero-lateral angles of the fourth a little more acute than the antero-lateral angles. The fifth is obliquely truncated behind. The endopodite of the first abdominal appendage of the male is broad and rounded (Pl. II. fig. 5), and the outer lobe *a* of the terminal joint is subtriangular, and much larger, but shorter, than the inner, which is separated from it by a suture. The fixed limb of the forceps *e* is as long as the movable limb *b*, and it ends in two hooks on its internal edge, one of which points towards the tip and the other towards the base of the appendage.

*Habitat.*—Amboina, 15 fathoms; one male.

*Remarks.*—This species bears a close resemblance to *Chlorida decorata*, Wood-Mason, from the Andamans, and to *Chlorida microphthalma*, Eydoux and Souleyet (*Squilla microphthalma*, Milne-Edwards), from India, but it is readily distinguished from the former by the fact that its telson is smooth below, and with scattered rounded tubercles above, while the telson of *Chlorida decorata* is described as vermiculated above and below by granulated ridges.

The presence of four instead of five teeth on the dactyle of the raptorial claw, and the shortness of the rostrum, distinguish it from *Squilla* (*Chlorida*) *microphthalma*, as briefly described by Milne-Edwards; and the presence of five teeth on the raptorial claw, of long acute spines on the lateral edges of the second thoracic somite, and the fact that the postero-lateral angles of the first four abdominal somites are obtuse, distinguish it from *Chloridella microphthalma* (*depressa*) of Miers. The outline and dorsal surface of the telson are also quite different from Miers' figure, while the whole anterior end of the body, especially the rostrum and eyes, is so different from his figure that there can be no doubt of its distinctness.

The genus *Chlorida*, Eydoux and Souleyet (*Chloridella*, Miers) is characterised by the fact that the eyes are constricted at the tip and dilated near the base. It includes four

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tips of eyes to tip of telson, | 1·50 | |
| Measurements on middle line:— | | |
| Total length from tip of rostrum to tip of telson, | 1·57 | |
| Rostrum, | ·0375 | 24 |
| Carapace, | ·3075 | 196 |
| Total length of carapace, including rostrum, | ·3450 | 220 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·0700 | 45 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·0625 | 40 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·0675 | 43 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·0850 | 54 |
| First abdominal somite, | ·1125 | 72 |
| Second abdominal somite, | ·1250 | 80 |
| Third abdominal somite, | ·1125 | 72 |
| Fourth abdominal somite, | ·1250 | 80 |
| Fifth abdominal somite, | ·1475 | 94 |
| Sixth abdominal somite, | ·0875 | 56 |
| Telson on middle line, | ·2275 | 145 |
| Total length of hind body, | 1·2225 | 781 |
| Total length on middle line, | 1·5675 | 1000 |
| Width of carapace between antero-lateral spines, | ·1750 | 112 |
| Width of carapace (greatest), | ·3225 | 206 |
| Width of second thoracic somite, | ·2725 | 174 |
| Width of third thoracic somite, | ·2625 | 168 |
| Width of fourth thoracic somite, | ·2975 | 190 |
| Width of fifth thoracic somite, | ·3125 | 200 |
| Width of first abdominal somite, | ·3750 | 240 |
| Width of second abdominal somite, | ·3774 | 241 |
| Width of third abdominal somite, | ·3824 | 245 |
| Width of fourth abdominal somite, | ·3900 | 250 |
| Width of fifth abdominal somite, | ·4124 | 264 |
| Width of sixth abdominal somite, | ·3974 | 254 |
| Width of telson, between postero-median spines, | ·0824 | 53 |
| Width of telson, between postero-lateral spines, | ·2450 | 157 |
| Width of telson (greatest), | ·3875 | 248 |
| Greatest length of telson, | ·2850 | 182 |
| Length of sixth abdominal appendage, | ·3675 | 225 |
| Distance between same, | ·8000 | 512 |
| Length of eye, | ·1000 | 64 |
| Width of eye, | ·0525 | 34 |
| Total length of first antenna, measured from tip of rostrum, | ·4500 | 288 |
| Total length of flagellum of second antenna, | ·3625 | 232 |
| Total length of scale of second antenna, | ·1500 | 96 |

species, one of which, *Chloridella rotundicauda*, Miers, is represented by a single female specimen; another, *Chlorida latreilii*, E. and S., by a single mutilated specimen; while

a third, *Chlorida decorata*, Wood-Mason, is very briefly and inadequately described, and the fourth, *Chlorida microphthalma*, E. and S., by no means satisfactorily known.

Our species would belong to the genus if the shape of the eyes were the criterion, but it is so perfectly connected with *Squilla fasciata*, a true *Squilla*, through the species which was last described, *Squilla lata*, that the propriety of retaining the genus *Chloridella* must remain very doubtful for the present. A comparison of this species (Pl. II. fig. 1), *Squilla lata* (Pl. III. fig. 1), and *Squilla fasciata* (Pl. III. fig. 4), will show that no one of these three species should be placed in a genus which does not include the other two, and as the last is clearly a true *Squilla* I have included all three in this genus.

The comparative table of measurements of the three species which is given at the end of the description of *Squilla fasciata* will also serve to show the close resemblance much better than a description.

## Genus *Lysiosquilla*, Dana.

*Diagnosis.*—Stomatopoda with the sixth abdominal somite separated from the telson by a movable joint; the hind body depressed, loosely articulated and wide; the dactyle of the raptorial claw without a basal enlargement, but with more than six marginal spines; no more than four secondary spines, and often only one, between the intermediate and submedian spines of the telson, which is usually wider than long; and the outer spine of the ventral prolongation from the basal joint of the uropod usually longer than the inner. The larva is an *Erichthus* or *Squillerichthus*, with the ocular and antennulary somites covered by the carapace; the lateral edges of the deep carapace folded inwards over the ventral surface; the bases of the postero-lateral spines distant from the dorsal middle line; the hind body flat and wide; the telson wider than long, and with few spines or only one between the intermediate and submedian spines; and the dactylus of the raptorial claw with numerous marginal spines.

*Special Description.*—I have examined the first abdominal appendage of the males of two species, *Lysiosquilla maculata* (Pl. X. fig. 6) and *Lysiosquilla excavatrix* (Pl. X. fig. 12), and find such great and characteristic difference from *Squilla*, that I do not hesitate to add to the diagnostic characteristics of the genus the statement that *Lysiosquilla* is distinguished by the fact that the terminal joint of the exopodite of the first abdominal appendage of the adult male is subtriangular, with its large outer lobe separated by a suture from the very small inner lobe, and the fixed limb of the petasma very small and not ending in a hook.

Like the genus *Squilla* the genus *Lysiosquilla* includes two minor groups, a highly specialized one and a more primitive and slightly modified one. The single specimen of *Lysiosquilla* (*Coronis*) *scolopendra* upon which Latreille based his genus *Coronis*, was

very imperfectly described, and it has unfortunately been lost; but his description and the figures which were afterwards published by Milne-Edwards, show such a close resemblance to *Lysiosquilla excavatrix*, n. sp., described below, that there can be no doubt of their very intimate relationship or of the importance of the differences between them and Dana's *Lysiosquilla inornata*, upon which this author based his genus *Lysiosquilla*, which has broad triangular eyes, large antennary scales, filiform appendages to the last three thoracic legs, and the larva of the closely related *Lysiosquilla maculata* has a short rostrum and postero-lateral spines; while *Lysiosquilla* (*Coronis*) *excavatrix* has small subcylindrical eyes, minute antennary scales and uropods, dilated appendages to the last three thoracic limbs, and the rostrum and postero-lateral spines of its larva are very long.

Notwithstanding these important differences the various species agree in many features, such as the presence of numerous spines on the dactyle, and of very few between the submedian and intermediate spines of the telson, in the loose articulation of the wide flat hind body, and the absence of dorsal carinæ. They cannot be arranged in two divergent groups, and it is impossible to draw any abrupt line between them. There can, therefore, be no doubt of the propriety of including them in one genus, as Miers[1] does, retaining Dana's term *Lysiosquilla* for all of them.

The higher and lower forms stand in precisely the same relation to each other as do *Squilla* and *Chloridella*, and there is also a most suggestive similarity in the character of the differences. In fact it is almost as difficult to detect generic differences between *Coronis* and *Chloridella* as between the latter and *Squilla*, or between *Coronis* and the higher *Lysiosquilla*.

The two genera *Squilla* and *Lysiosquilla* are divergent stems from a common stalk, and while the higher forms are quite distinct, the resemblance between the lower forms is no more than we should expect.

While there can be no doubt that all the very wide *Erichthi* with a deep infolded carapace are *Lysiosquilla* larvæ, we cannot state with confidence that all *Lysiosquillæ* have larvæ of this type, for there are no strongly marked and constant differences between the *Lysioerichthus* and the *Gonerichthus* and *Pseuderichthus*, and it is not impossible that some of the narrow elongated *Pseuderichthi* may be *Lysiosquilla* larvæ.

In some of the *Lysiosquillæ*, and possibly in all of them, there are marked secondary differences between the sexes.

*Lysiosquilla maculata* (Fabricius) (Pl. X. figs. 1–7).

The Challenger collection includes four specimens of this well-known and widely distributed species; one full-grown male, No. 1, presented by the king of Amboina; a half-grown male, No. 3, from Amboina, and a mature male and female, No. 2, from

[1] Miers, On the Squillidæ, p. 3.

Samboangan. Miers has called attention[1] to the fact that in the single female with the large raptorial limbs which he has been able to examine, the spines arming the inner margin of the dactylus, instead of being strong and elongated as in the males, are very short, and towards the base are reduced to little more than small serrations or teeth. The fact that there is the same difference between the raptorial claws of the males and that of the female in the Challenger series would seem to indicate that this difference between the sexes is constant. The raptorial claw of a large male is shown in Pl. X. fig. 1, and that of the female in fig. 2. This difference is the more remarkable as secondary structural differences between the sexes are extremely rare among the Stomatopods. The male of *Pseudosquilla ciliata* is said to be more brilliantly coloured than the female, and the female *Lysiosquilla excavatrix* is larger and darker coloured than the male, but there are no structural differences except the modification of the endopodite of the first abdominal appendage which is found in all male Stomatopods. The sterna of the free thoracic somites of the female *Lysiosquilla maculata* are much thicker and stouter than those of the male, and the median ventral carinæ larger.

The first abdominal appendage of the male is shown in Pl. X. fig. 6. The endopodite is elongated and shorter than the exopodite *ex*, and its terminal joint B is triangular, wider than long, with the inner lobe *h* very much smaller than the outer lobe *a*, from which it is separated by a suture. The inner lobe is nearly circular, with a deep notch on its distal edge; the appendix interna is long and prominent; the movable limb *f* of the forceps is acute and long, while the immovable limb is very small and scarcely visible.

*Ontogeny.*—The largest *Erichthus* larva in the Challenger collection, a *Lysioerichthus*, is the same as the one shown in Claus's figure 16, and probably identical with *Erichthus duvaucellei*, Guér. It is shown in Pl. X. fig. 7. It is very widely distributed, and the collection contains numerous specimens from various localities in the West Pacific. Specimens were taken in the tow-net between Api and Cape York, between Admiralty Island and the coast of Japan, in the Straits of Mindoro, and at other points, while Claus's specimens were obtained in the Indian Ocean, and Guérin's in the Gulf of Bengal.

Its resemblance to the larva from which I have reared *Lysiosquilla excavatrix* shows that it is a *Lysiosquilla*, and, like *Lysiosquilla maculata*, it is somewhat exceptional, since the inner spine of the uropod is longer than the outer, while most of the adult *Lysiosquillæ*, and most of the *Lysioerichthus* larvae, have the outer spine longest. The raptorial claw is long and slender, and it exhibits traces of eight marginal spines, while the adult female *Lysiosquilla maculata* has seven or eight and the adult male nine.

The abdomen of the oldest larva is marked by the transverse dark bands which are so characteristic of the adult *Lysiosquilla maculata*, and I cannot doubt that this

[1] Miers, On the Squillidæ, p. 6.

| Measurements.[1] | In inches. | | | In thousandths of total length. | | |
|---|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 1. | No. 2. | No. 3. |
| Total length on middle line from tip of rostrum to tip of telson, | $11\frac{13}{16}$ | $9\frac{11}{16}$ | $5\frac{30}{32}$ | | | |
| Rostrum, | $\frac{7}{16}$ | $\frac{5}{16}$ | $\frac{4}{16}$ | ·037 | ·032 | ·04 |
| Carapace, | $1\frac{15}{16}$ | $1\frac{10}{16}$ | 1 | ·164 | ·168 | ·166 |
| From tip of rostrum to middle of posterior edge of carapace, | $2\frac{6}{16}$ | $1\frac{15}{16}$ | $1\frac{4}{16}$ | ·201 | ·200 | ·206 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | $\frac{9}{16}$ | $\frac{6}{16}$ | $\frac{4}{16}$ | ·048 | ·039 | ·04 |
| From posterior edge of second to posterior edge of third thoracic somite, | $\frac{9}{16}$ | $\frac{7}{16}$ | $\frac{5}{16}$ | ·048 | ·045 | ·05 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | $\frac{11}{16}$ | $\frac{9}{16}$ | $\frac{5}{16}$ | ·058 | ·058 | ·05 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | $\frac{12}{16}$ | $\frac{9}{16}$ | $\frac{5}{16}$ | ·063 | ·058 | ·05 |
| First abdominal somite, | $\frac{15}{16}$ | $\frac{12}{16}$ | $\frac{7}{16}$ | ·079 | ·077 | ·07 |
| Second abdominal somite, | $\frac{14}{16}$ | $\frac{11}{16}$ | $\frac{7}{16}$ | ·074 | ·071 | ·07 |
| Third abdominal somite, | $\frac{14}{16}$ | $\frac{12}{16}$ | $\frac{7}{16}$ | ·074 | ·077 | ·07 |
| Fourth abdominal somite, | $\frac{14}{16}$ | $\frac{12}{16}$ | $\frac{7}{16}$ | ·074 | ·077 | ·07 |
| Fifth abdominal somite, | $1\frac{2}{16}$ | $\frac{14}{16}$ | $\frac{8}{16}$ | ·095 | ·09 | ·08 |
| Sixth abdominal somite, | $\frac{12}{16}$ | $\frac{12}{16}$ | $\frac{13}{32}$ | ·063 | ·077 | ·067 |
| Telson on middle line, | $1\frac{7}{16}$ | $1\frac{4}{16}$ | $\frac{14}{16}$ | ·122 | ·129 | ·145 |
| Total length of hind body, | $9\frac{7}{16}$ | $7\frac{12}{16}$ | $4\frac{22}{32}$ | ·798 | ·798 | ·762 |
| Total length on middle line from tip of rostrum to tip of telson, | $11\frac{13}{16}$ | $9\frac{11}{16}$ | $5\frac{30}{32}$ | ·999 | ·998 | ·968 |
| Width of carapace at anterior end, | $1\frac{4}{16}$ | 1 | $\frac{11}{16}$ | ·106 | ·103 | ·117 |
| Greatest width of carapace, | $1\frac{14}{16}$ | $1\frac{10}{16}$ | 1 | ·159 | ·168 | ·168 |
| Width of second thoracic somite, | $1\frac{1}{16}$ | 1 | $\frac{9}{16}$ | ·090 | ·103 | ·095 |
| Width of third thoracic somite, | $1\frac{5}{16}$ | $1\frac{5}{16}$ | $\frac{10}{16}$ | ·111 | ·135 | ·105 |
| Width of fourth thoracic somite, | $1\frac{9}{16}$ | $1\frac{6}{16}$ | $\frac{12}{16}$ | ·132 | ·155 | ·126 |
| Width of fifth thoracic somite, | $1\frac{11}{16}$ | $1\frac{11}{16}$ | $\frac{14}{16}$ | ·143 | ·174 | ·147 |
| Width of first abdominal somite, | $2\frac{3}{16}$ | $1\frac{15}{16}$ | $1\frac{2}{16}$ | ·185 | ·200 | ·189 |
| Width of second abdominal somite, | $2\frac{3}{16}$ | $2\frac{1}{16}$ | $1\frac{3}{16}$ | ·185 | ·213 | ·200 |
| Width of third abdominal somite, | $2\frac{5}{16}$ | $2\frac{1}{16}$ | $1\frac{3}{16}$ | ·196 | ·213 | ·200 |
| Width of fourth abdominal somite, | $2\frac{5}{16}$ | $2\frac{1}{16}$ | $1\frac{3}{16}$ | ·196 | ·213 | ·200 |
| Width of fifth abdominal somite, | $2\frac{4}{16}$ | 2 | $1\frac{2}{16}$ | ·190 | ·206 | ·200 |
| Width of sixth abdominal somite, | $2\frac{2}{16}$ | $1\frac{14}{16}$ | $1\frac{2}{16}$ | ·180 | ·194 | ·189 |
| Width of telson between postero-median spines, | $\frac{15}{16}$ | 1 | $\frac{10}{16}$ | ·080 | ·103 | ·105 |
| Width of telson between postero-lateral spines, | $1\frac{14}{16}$ | $1\frac{9}{16}$ | $1\frac{1}{16}$ | ·159 | ·161 | ·179 |
| Greatest width of telson, | $2\frac{2}{16}$ | $1\frac{13}{16}$ | $1\frac{2}{16}$ | ·180 | ·187 | ·189 |
| Eye stalk, | $\frac{3}{16}$ | $\frac{5}{32}$ | ... | ·016 | ·016 | ... |
| Eye, | $\frac{7}{16}$ | $\frac{10}{32}$ | ... | ·037 | ·032 | ... |
| Width of eye, | $\frac{8}{16}$ | $\frac{7}{16}$ | ... | ·042 | ·045 | ... |
| First antenna, first joint, | $\frac{7}{16}$ | ... | ... | ·037 | ... | ... |
| First antenna, second joint, | $\frac{6}{16}$ | ... | ... | ·032 | ... | ... |
| First antenna, third joint, | $\frac{6}{16}$ | ... | ... | ·032 | ... | ... |
| First antenna, longest flagellum, | $1\frac{8}{16}$ | ... | ... | ·127 | ... | ... |
| Flagellum of second antenna, | 2 | ... | ... | ·166 | ... | ... |
| Scale of second antenna, | $1\frac{6}{16}$ | ... | ... | ·116 | ... | ... |
| Antenna of segment, | $\frac{7}{16}$ | ... | ... | ·037 | ... | ... |
| Labrum, | 1 | $\frac{14}{16}$ | ... | ·084 | ·090 | ... |

[1] No. 1, adult male; No. 2, adult female; No. 3, half-grown male.

large, widely distributed, transversely banded larva is the young of *Lysiosquilla maculata*, which is one of the largest and most widely distributed Stomatopods. The value of this identification can be much better estimated after examination of the section on Stomatopod larvæ.

*Lysiosquilla* (*Coronis*) *excavatrix*, n. sp. (Pl. X. figs. 8–16).

*Diagnosis.*—Body depressed and loosely articulated; whole dorsal surface smooth. Carapace, with rostrum, making $\frac{17}{100}$ of the total length from tip of rostrum to tip of telson. Eyes nearly cylindrical, with hemispherical corneæ. Scale of second antenna about $\frac{4}{100}$ of total length. Raptorial claw of second maxilliped oval, with fourteen or fifteen short curved pointed teeth and a much longer terminal tooth on dactylus, and three movable spines on inner side of base of second joint. Second thoracic somite with a blunt rounded lobe on each side. Appendages of third, fourth, and fifth pereiopods ovate, that of the fourth being largest. Sixth abdominal somite with a long acute process on each side, near anterior edge. Telson smooth, nearly rectangular, with one median and two pairs of lateral subacute lobes. Endopodite of sixth abdominal appendage triangular, basal prolongation ending in two simple acute curved spines, the outer much the larger. Larva a long-spined *Lysioerichthus*.

*General Description.*—The carapace is smooth on its dorsal surface, with the gastric sutures distinct from the anterior edge to the transverse cervical suture, behind which no longitudinal sutures are visible. The space included between the gastric sutures is wide and makes up rather more than two-thirds of the total width of the carapace. This is elongated and slightly narrowed anteriorly, with the antero-lateral angles nearly right angles and the postero-lateral angles broadly rounded. The anterior edge of the carapace is nearly transverse, and it is very deeply emarginated on the middle line behind. Its length on the middle line is $\frac{17}{100}$, and its greatest breadth about $\frac{12}{100}$ of the total length. The rostrum is a little longer than wide and the lateral edges are not angulated, but are strongly convex in outline and regularly curved to the base of the short acuminate tip. The rostrum completely covers the ocular somite, and hides the base of the eyes. The first antennary somite ends laterally in long slender acute spines, which curve outwards and forwards.

The first antennæ are very short and their shafts are hidden nearly to the tips below the eyes, which are small, subcylindrical, with terminal hemispherical corneæ, and are usually directed forwards side by side. The second antennæ are almost as long as the first, and the oval scale is very narrow and short, its length being only $\frac{35}{1000}$ of the total length of the body.

The second joint or propodus of the raptorial claw is broad, with an obscure longitudinal ridge on its outer surface, and when the dactylus is closed the claw is oval and nearly

flat. The dactylus (Pl. X. fig. 11) is armed with fourteen or fifteen sharp curved teeth, besides the terminal tooth, which is more than three times as long as any of the others. There are three stout movable spines on the inner edge of the second joint near the base, while the outer edge is fringed with numerous small immovable pectinations.

The carapace does not completely hide the dorsal surface of the first thoracic somite. The second thoracic somite is prolonged on each side near its posterior edge into a rounded lobe which projects backwards, while the lateral edges of the third, fourth, and fifth thoracic somites are entire and longitudinal, with rounded antero- and postero-lateral angles.

The thoracic somites are much narrower than the carapace, and they increase regularly in width from the second to the fifth, which is less than two-thirds as wide as the first abdominal. The first five abdominal somites are nearly equal in width and also in length, their transverse diameter being about $\frac{14}{100}$ and their average length about $\frac{10}{100}$ of the total length of the body. They are a little $(\frac{7}{6})$ wider than the carapace. The sixth abdominal somite is considerably narrower than the fifth, and slightly narrower than the carapace, its transverse diameter being less than $\frac{10}{100}$ of the total length of the body. It is about twice as wide as long. On the lateral margin on each side, close to the anterior edge, there is a prominent acute curved process, but its posterior edge is entire, and the suture which separates it from the telson is very obscure, but movable. The whole dorsal surface of the rostrum, carapace, hind body, and telson is smooth and highly polished, and without carinæ or spines.

The telson is as wide as the sixth abdominal somite, nearly rectangular, and $\frac{7}{12}$ as long as wide, its length being about $\frac{7}{100}$ of the total length of the body. Its posterior edge is transverse, as long as the anterior edge, and nearly straight, and it is divided, in the adult, by four concave notches into five subacute lobes, of which one is on the middle line, and two on each side, all nearly equidistant. In the young the median lobe is represented by a pair of submedian spines, with minute setæ on the margin of the telson between them.

The exposed thoracic limbs are short and their appendages are broad, oval, and membranous. The uropods are small and little used in locomotion; the endopodite is triangular, and the ventral prolongation from the basal joint ends in two acute, curved, unarmed spines, of which the outer is much the larger. The anterior process of the mandible is bordered by two rows of irregular obtusely rounded dentations, which are continued to the tip where there are two terminal dentations. The endopodite of the first maxilla, fig. 9, ends in a stout acute curved spine, which carries on its outer surface two stout movable hairs and one slender one. The outer surface of the second maxilla, fig. 10, is smooth, and is not divided into lobes by a median furrow.

The first five pairs of abdominal appendages are furnished with very large exopodites

which overlap on the middle line. The endopodite of the first abdominal appendage of the male is shown in Pl. X. fig. 12. It is very much smaller than the exopodite, triangular, and as wide as long. The inner lobe *b* of the terminal joint is very small, nearly circular, and separated by a suture from the broad triangular outer lobe *a*. The movable limb of the petasma is long, nearly straight, and armed on its outer edge, near the base, with an acute spine, while the fixed limb is very short and without a hook at the tip, which is rounded, as is the case in *Lysiosquilla maculata*. The sexes of this species are quite different from each other, and it seems probable that secondary sexual differences may occur in all the flat loosely articulated Stomatopods.

The character of the difference between the sexes is however quite different from what we find in *Lysiosquilla maculata*. In the latter species the sexes are alike in size and colour, and they differ in structural features, while in this species there are no structural differences except those which are concerned in reproduction, but the female is much larger than the male, and of an opaque olive brown, almost black colour, while the male is of a transparent grey.

*Habits.*—As our information regarding the habits of the Stomatopoda is very scanty, I give all that I have been able to learn of the habits of this species. It is found in the sand of the ocean beach just below low-tide mark, where it is exposed to the full force of the ocean swell, and it inhabits a very deep cylindrical burrow which is nearly vertical and goes down for several feet. While watching for its prey the animal stations itself at the mouth of the burrow, which is arched over with sand, so that only the tips of the eyes are exposed. The food consists of small Crustacea, fishes and other small animals, and when one approaches within reach the *Coronis* darts out of the burrow, knocking away the loose sand, and seizing it in its raptorial claw it darts backwards with it and retreats to the bottom of the burrow. When hungry it often captures prey at a distance of six or eight inches, but, as a rule, it waits until it is near enough to be caught without leaving the opening. The food which is captured is usually stored away at the bottom of the burrow, and the animal returns to the mouth and resumes its watch. In excavating its burrow the animal begins by stretching its body out on the sand, which is then swept away from under it by the action of the abdominal appendages, until all of the body except the eyes and telson are buried. It then forces its head into the loose sand which has been stirred up by the action of the abdominal appendages, and dragging its body down it quickly becomes buried vertically, head downwards, and it continues to burrow until it reaches the hard undisturbed sand, when it bends upon itself, and passing the head up on the ventral side of the swimmerets it reverses its position and works upwards to the surface, hardening and compressing the sand by the pressure of the dorsal surface. After the upper end of the burrow is thus rendered firm and circular it again doubles upon itself, and going to the bottom gathers an armful of sand, which is clasped against the ventral surface of the body between the large second maxillipeds, where it is

held in place by the flat oval chelæ which are tightly clasped over it. At the opening it stretches out as far as it can reach without leaving the burrow, and dropping the armful of sand it smooths it down until it is level with the surrounding surface. This process is then repeated until the burrow reaches a great depth, for I have dug for three or four feet without reaching the end, and all the specimens which I kept in confinement burrowed to the bottom of the aquarium.

When the burrow is finished the animal spends most of its time near the top, and as the semicircular exopodites of the abdominal appendages complete the outline formed by the convex dorsal surface, it completely fills the circular tube, into which the constantly vibrating scoop-like abdominal appendages carry a continuous current of water, which escapes through the loose sand.

The whole organisation of the species,—the convex body, the semicircular swimmerets, the small closely approximated eyes, and the broad flat claws,—adapt it for its mode of life, and it is doubtful whether any other species is more completely subterranean in its habits. Although it is very common at Beaufort, I have captured only one specimen while swimming, and it very rarely ventures more than a few inches from the burrow.

Its movements when seizing its prey are so rapid that the eye can scarcely follow them, and the attempt to cut off its retreat with a trowel usually results in cutting the animal in two, although this is the only method of capturing them which I have found at all successful.

This species, when kept in confinement, makes a faint stridulating noise by rubbing the uropod against the lower surface of the telson. *Squilla empusa* stridulates vigorously in the same way, and its habits, which I have also had an opportunity to observe, are quite different from those of *Lysiosquilla excavatrix*. It is very active, swimming swiftly through the water, and pursuing its prey to a great distance from its burrow, so that it is frequently captured in the water by the trawl or sein. It inhabits muddy rather than sandy bottoms, and its burrow is a shallow U-shaped tube, open at both ends, and excavated entirely by the action of the current of water which is set up by the abdominal appendages.

*Ontogeny.—Lysiosquilla excavatrix* is one of the few Stomatopods which have been traced through their metamorphoses, and the fully grown larva, which is a long-spined *Lysioerichthus*, is shown in Pl. XI. figs. 1–3.

I shall show in the section on Stomatopod larvæ that it probably hatches as an *Erichthoidina*, with five pairs of biramous thoracic appendages; the sixth, seventh, and eighth thoracic somites distinct but without appendages, and the telson joined to the last thoracic somite with no intervening abdominal region. In the youngest *Erichthus* stage, however, there is a long segmented abdomen with four pairs of fully developed appendages, and the thoracic somites from the third to the eighth have no appendages, while those of the first and second thoracic somites have their adult form. The lateral edges of

the young *Erichthus* are bordered with spines as in *Alima*, and the general structure of the larva is very *Alima*-like; a resemblance which totally disappears in the older larvæ.

*Habitat.*—Common below low water mark on sandy beaches at Beaufort, N.C., U.S.A.

| Measurements. | In hundredths of inch. | | In thousandths of total length. | |
|---|---|---|---|---|
| | Large male. | Large female. | Large male. | Large female. |
| Total length on middle line from tip of rostrum to tip of telson, | 2·41 | 3·02 | ... | ... |
| Rostrum, | ·10 | ·11 | ·041 | ·036 |
| Carapace, | ·33 | ·39 | ·137 | ·129 |
| Total length of carapace and rostrum, | ·43 | ·50 | ·178 | ·165 |
| From posterior edge of carapace to posterior edge of second thoracic somite, | ·04 | ·12 | ·017 | ·039 |
| From posterior edge of second to posterior edge of third thoracic somite, | ·10 | ·14 | ·041 | ·046 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·13 | ·17 | ·054 | ·056 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·16 | ·20 | ·066 | ·073 |
| First abdominal somite, | ·24 | ·28 | ·100 | ·092 |
| Second abdominal somite, | ·25 | ·29 | ·104 | ·095 |
| Third abdominal somite, | ·25 | ·30 | ·104 | ·099 |
| Fourth abdominal somite, | ·26 | ·30 | ·108 | ·099 |
| Fifth abdominal somite, | ·25 | ·30 | ·104 | ·099 |
| Sixth abdominal somite, | ·13 | ·18 | ·054 | ·059 |
| Telson, | ·17 | ·24 | ·070 | ·079 |
| Total length of hind body, | 1·98 | 2·52 | ·822 | ·836 |
| Total length on middle line, | 2·41 | 3·02 | 1·000 | 1·001 |
| Width of carapace at anterior end, | ·20 | ·24 | ·083 | ·079 |
| Greatest width of carapace, | ·30 | ·33 | ·125 | ·109 |
| Width of second thoracic somite, | ·13 | ·22 | ·054 | ·073 |
| Width of third thoracic somite, | ·22 | ·30 | ·091 | ·099 |
| Width of fourth thoracic somite, | ·24 | ·32 | ·100 | ·106 |
| Width of fifth thoracic somite, | ·25 | ·34 | ·104 | ·112 |
| Width of first abdominal somite, | ·31 | ·45 | ·129 | ·149 |
| Width of second abdominal somite, | ·31 | ·46 | ·129 | ·152 |
| Width of third abdominal somite, | ·32 | ·46 | ·133 | ·152 |
| Width of fourth abdominal somite, | ·32 | ·46 | ·133 | ·152 |
| Width of fifth abdominal somite, | ·31 | ·46 | ·129 | ·152 |
| Width of sixth abdominal somite, | ·26 | ·34 | ·108 | ·112 |
| Greatest width of telson, | ·29 | ·36 | ·120 | ·119 |
| Length of first antenna from tip of rostrum to tip of longest flagellum, | ·38 | ·36 | ·158 | ·119 |
| Length of appendage of second antenna, | ·35 | ... | ·145 | ... |
| Length of scale of second antenna, | ·08 | ·12 | ·032 | ·04 |
| Length of eye, | ·09 | ·09 | ·037 | ·029 |
| Total length of swimmeret, | ·38 | ·42 | ·158 | ·139 |

*Size.*—Males from two to three inches long; females from two and one-half to four inches long.

*Colour.*—Males transparent, with small dark brown pigment spots uniformly distributed, giving the body a greyish tint; females more opaque and of a dark olive brown, nearly black, colour.

*Remarks.*—This species seems to be very closely related to *Lysiosquilla polydactyla*, but there can be no doubt of its specific distinctions.

### Genus *Pseudosquilla*, Guérin.

*Diagnosis.*—Stomatopoda with the sixth abdominal somite separated from the telson by a movable joint; the hind body smooth, convex, and narrow; the dactyle of the raptorial claw without a basal enlargement, and with few marginal spines or none; the submedian spine of the telson long, and tipped with movable spinules, with usually a single secondary spinule, sometimes two, three, or four, between the submedian and intermediate marginal spines; the terminal joint of the first abdominal appendage of the male imperfectly divided by a marginal notch into an inner and an outer lobe; larva an elongated narrow *Erichthus*, with a short narrow carapace, with the postero-lateral spines near the dorsal middle line, and the lateral edges slightly or not at all infolded; the telson longer than wide, with long submedian spines; the proximal joint of the exopodite of the uropod with numerous spines, and the outer spine of the basal prolongation much longer than the inner and longer than the telson.

*Pseudosquilla ciliata*, Miers (Pl. XV. fig. 10).

*Pseudosquilla ciliata*, Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 108, pl. iii. figs. 7, 8.

The Challenger collection includes two specimens of this well-known species, a male and a female, from 2 fathoms depth at St. Thomas, and also a male from the reefs at Honolulu.

The raptorial claws, the spines of the telson, and the paddles and spines of the uropods retain, in the alcoholic specimen, the bright cherry red colour which, according to G. Clark, is exhibited by the living animal. The alcoholic specimens also have eye-like spots of black pigment near the lateral edges of the third thoracic and first abdominal somites, and another on the dorsal surface of the base of the telson on the middle line. The occurrence of this Pacific species at St. Thomas is a remarkable fact in the distribution of the Stomatopoda, but it will probably be found to be widely distributed throughout the Atlantic as well as the Pacific, for Von Martens records it from Cuba. The specimens from St. Thomas agree perfectly in measurements as well as in most other respects with the one from Honolulu. The only differences which I have been able to detect are the following: the paddle of the exopodite of the uropod is about as long as the second joint in the specimens from the Pacific, while it is a little shorter in the two

| Measurements of male specimen from Honolulu. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length on middle line, from tip of rostrum to edge of telson | 2·13 | |
| Measurements on middle line:— | | |
| Rostrum, | ·12 | 56 |
| Carapace, | ·54 | 254 |
| Carapace, including rostrum, | ·66 | 310 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·12 | 56 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·10 | 47 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·10 | 47 |
| First abdominal somite, | ·16 | 75 |
| Second abdominal somite, | ·16 | 75 |
| Third abdominal somite, | ·16 | 75 |
| Fourth abdominal somite, | ·16 | 75 |
| Fifth abdominal somite, | ·22 | 104 |
| Sixth abdominal somite, | ·14 | 66 |
| Telson on middle line, | ·15 | 70 |
| Total length of hind body, | 1·47 | 690 |
| Total length on middle line, | 2·13 | 1000 |
| Greatest length of telson, | ·38 | 178 |
| Width of rostrum, | ·20 | 94 |
| Width of carapace at antero-lateral angles, | ·32 | 150 |
| Width of carapace (greatest), | ·44 | 208 |
| Width of third thoracic somite, | ·42 | 197 |
| Width of fourth thoracic somite, | ·42 | 197 |
| Width of fifth thoracic somite, | ·42 | 197 |
| Width of first abdominal somite, | ·46 | 216 |
| Width of second abdominal somite, | ·46 | 216 |
| Width of third abdominal somite, | ·46 | 216 |
| Width of fourth abdominal somite, | ·46 | 216 |
| Width of fifth abdominal somite, | ·46 | 214 |
| Width of sixth abdominal somite between postero-lateral spines, | ·38 | 178 |
| Width of telson (greatest), | ·38 | 178 |

specimens from St. Thomas; the specimen from Honolulu has the inner spine of the ventral prolongation from the base of the uropod much longer than the outer, while the two spines are of equal length in the two specimens from St. Thomas; in the specimens from St. Thomas the postero-lateral angles of the fourth, fifth, and sixth abdominal appendages end acutely in spines, while this is the case with the fifth and sixth only in the specimen from Honolulu. In all the specimens the lateral lobes of the last thoracic somite are bidentate.

Miers is undoubtedly correct in his decision that v. Marten's *Pseudosquilla stylifera* from Cuba is a *Pseudosquilla ciliata*, and it is probable that it ranges very widely over

both the Atlantic and the Pacific, with slight differences between the specimens from widely separated localities, and *Pseudosquilla oculata*, Brullé, from the Canaries and Madeira, may possibly prove to be one of these varieties of *Pseudosquilla ciliata*, but the species of *Pseudosquilla* all need careful revision, as there is evidently considerable variability. Peculiarities of colouration are unsafe guides in the study of preserved specimens, and most of the other marks for the discrimination of species are known to vary. Thus Heller says that his *Pseudosquilla oculata* (*Pseudosquilla ornata*, Miers) may be distinguished from *Pseudosquilla stylifera* (*Pseudosquilla ciliata*, Miers) by the fact that the spine of the uropod is longer than the endopodite, but Miers' figure of *Pseudosquilla ciliata* (Squillidæ, pl. iii. fig. 8) represents the spine as longer than the endopodite uropod, and this is true of the Challenger specimens also.

## Genus *Gonodactylus*, Latreille.

*Diagnosis.*—Stomatopoda with the sixth abdominal somite separated from the telson by a movable joint; the hind body convex; and the dactylus of the raptorial claw enlarged at the base, and without marginal spines. Larva, an *Erichthus*, has the postero-lateral spines of the carapace near the dorsal middle line, the lateral edges not infolded, and hatches from the egg as an *Erichthoidina*, which becomes converted into an *Erichthus* without the loss of any of its appendages.

*Remarks.*—All the Stomatopods with a dilated unarmed dactylus on the second maxilliped are usually grouped in a single genus, *Gonodactylus*, but the collection of species which are thus brought together is a very heterogeneous one, and little examination is necessary to show that the genus, as usually characterised, includes at least three distinct assemblages of species. The species which have the sixth abdominal somite immovably fused with the telson are obviously more closely related to each other than they are to the other species of *Gonodactylus*, and as this fact should find its expression in the systematic zoology of the group I have placed these species by themselves in a distinct genus *Protosquilla*, retaining in the genus *Gonodactylus* only those species which have the telson movable. In the genus as thus restricted, two species, *Gonodactylus* (*Squilla*) *bradyi*, A. Milne-Edwards, and *Gonodactylus trachurus*, Miers, differ from all the remaining species in many features, such as the small size of the eyes, the scales of the second antennæ and the uropods; the depression of the hind body, and the presence of dentations on the inner edge of the dactylus of the raptorial claw. The propriety of separating these species from the true *Gonodactyli* seems obvious, and as they present many points of resemblance to both *Lysiosquilla* and *Squilla*, especially to the least specialised species in these two genera, I suggest for them the generic name, *Coronida*, compounded from *Coronis*, the generic name proposed by Latreille for the *Lysiosquillæ* with dilated appendages on the exposed thoracic limbs, and *Chlorida*,

the generic name proposed by Eydoux and Souleyet for the small-eyed *Squillæ*. The genus *Coronida* will therefore include the Stomatopods which have the dactyli of the raptorial claw dilated at the base and armed with spines on the inner margin, and the hind body depressed; while the genus *Gonodactylus*, as thus restricted by the removal of the *Protosquillæ* and the *Coronidæ*, will include only the species which have the hind body convex, the dactylus of the raptorial claw dilated at the base and unarmed, and the telson distinct and movable.

In the genus *Gonodactylus* as thus restricted the terminal joint of the first abdominal somite of the male is imperfectly divided, by a marginal notch, into an outer and an inner lobe, which are not separated by a suture (see Pl. XV. fig. 8).

The fixed limb of the petasma is short, and ends in a single acute hook, while the movable limb is abruptly bent outwards near its base.

*Gonodactylus chiragra*, Latreille (Pl. XV. fig. 4).

This common and widely distributed species is represented in the Challenger collection by numerous males and females from St. Thomas, one male from Bermuda, one male from Station 36, near Bermuda (32° 7′ 25″ N., 65° 4′ W.), by two specimens from Samboangan, and one specimen from Samboangan Bank, besides numerous adult male and female specimens of a closely related but minute variety from near Cape St. Roque. The appendages of the exposed thoracic limbs of all the specimens of *Gonodactylus chiragra* are slightly flattened, and twice as wide as thick, and their edges are parallel and not dilated at the tip. The second joint of the exopodite of the uropod is more than twice as long as the paddle, and it carries about eleven (ten in four specimens, eleven in seven specimens, nine or ten in Heller's specimen from Nicobars, twelve in two specimens) movable spines and one terminal ventral immovable spine.

The terminal joint of the endopodite of the male *Gonodactylus chiragra* is divided by a deep marginal notch into an outer lobe (Pl. XV. fig. 4) *a* and an inner one *b*, which is not separated from the outer one by a suture. The fixed limb of the petasma *e* is short, swollen at the base, and bent inwards at right angles at the tip, thus forming a hook which ends in an acute point. The much longer movable limb *f* is bent outwards in a prominent sharply defined obtuse angle near its base.

There seems to be no room for doubting that the specimens from various parts of the ocean which have been described as *Gonodactylus chiragra* really belong to one species, and that it is very widely distributed throughout the Atlantic, the Pacific, and the Indian Oceans. E. v. Martens says[1] that although he has formerly published his opinion that this species is confined to the Indian Ocean, and the Pacific from the Red Sea to Chili, the

[1] Ueber cubanische Crustaceen, nach den Sammlungen Dr. J. Gundlach's, *Archiv f. Naturgesch.*, 1872, Jahrg. xxxiii., Bd. ii. p. 147.

| Measurements of a female, *a*, from Bermuda and a male, *b*, from Samboangan. | In inches and decimals. | | In thousandths of total length. | |
|---|---|---|---|---|
| | *a.* | *b.* | *a.* | *b.* |
| Measurements along middle line:— | | | | |
| Rostrum, | ·12 | ·18 | 60 | 69 |
| Carapace, | ·43 | ·66 | 215 | 222 |
| Carapace, including rostrum, | ·55 | ·78 | 275 | 289 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·10 | ·14 | 50 | 52 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·12 | ·14 | 60 | 52 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·12 | ·14 | 60 | 52 |
| First abdominal somite, | ·14 | ·19 | 70 | 69 |
| Second abdominal somite, | ·14 | ·22 | 70 | 81 |
| Third abdominal somite, | ·16 | ·22 | 80 | 81 |
| Fourth abdominal somite, | ·18 | ·20 | 90 | 74 |
| Fifth abdominal somite, | ·19 | ·24 | 95 | 89 |
| Sixth abdominal somite, | ·12 | ·16 | 60 | 59 |
| Telson on middle line, | ·18 | ·27 | 90 | 100 |
| Total length of hind body, | 1·45 | 1·92 | 725 | 709 |
| Total length on middle line, | 2·00 | 2·70 | 1000 | 998 |
| Greatest length of telson, | ·29 | ·40 | 145 | 148 |
| Width of carapace between antero-lateral angles, | ·25 | ·34 | 125 | 126 |
| Width of carapace (greatest), | ·32 | ·46 | 160 | 170 |
| Width of sixth thoracic somite, | ·32 | ·50 | 160 | 185 |
| Width of seventh thoracic somite, | ·33 | ·50 | 165 | 185 |
| Width of eighth thoracic somite, | ·33 | ·50 | 165 | 185 |
| Width of first abdominal somite, | ·34 | ·52 | 170 | 192 |
| Width of second abdominal somite, | ·35 | ·52 | 175 | 192 |
| Width of third abdominal somite, | ·35 | ·52 | 175 | 192 |
| Width of fourth abdominal somite, | ·35 | ·52 | 175 | 192 |
| Width of fifth abdominal somite, | ·35 | ·52 | 175 | 192 |
| Width of sixth abdominal somite between postero-lateral spines, | ·32 | ·44 | 160 | 163 |
| Width of telson between sub-median spines, | ·11 | ·14 | 55 | 52 |
| Width of telson (greatest), | ·30 | ·44 | 150 | 163 |
| Length of eye, | ·14 | ... | 70 | ... |
| Length of first antenna from tip of rostrum, | ... | ·42 | ... | 155 |
| Length of second antenna from tip of rostrum, | ... | ·56 | ... | 207 |
| Length of scale, | ... | ·32 | ... | 118 |

absence of any decided difference between the specimen obtained in Cuba by Gundlach and those which he has himself collected at Amboina compels him to reverse this opinion and to recognise the occurrence of the species in the tropical Atlantic. He says that the specimens from the Atlantic are smaller on the average than those from the Indian Ocean, that the rostral spine is a little shorter. He points out also a slight variation among the Cuban specimens in the terminal spines

of the telson, as well as slight differences in the colour of the alcoholic specimens from the two previous localities.

Smith says[1] that specimens from the West Indian and Florida Keys do not differ from those collected at the Reefs of the Abrolhos at Caravella, Province of Bahia, Brazil, by Hartt, but he says that "the American species is, however, very likely distinct from the true *Gonodactylus chiragra*, from the Old World," although he gives no reason for this opinion. A. Milne-Edwards[2] records it from the Mediterranean, and coasts of America, Africa, Asia, and Oceania. Miers says that he has examined a specimen four inches long from New Guinea.

*Gonodactylus graphurus*, Miers (Pl. XIV. figs. 1, 4, 6; Pl. XV. figs. 3, 8).

*Gonodactylus graphurus*, Miers, Edw. J., On some new or undescribed Crustacea from the Samoan Islands, Ann. and Mag. Nat. Hist., ser. 4, vol. xvi. p. 344, 1875.

*Gonodactylus graphurus*, Miers, Edw. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 120, pl. iii. fig. 9.

*Gonodactylus graphurus*, White, List of Crustacea, Brit. Mus., 1849, p. 85 (no description).

*Gonodactylus graphurus*, Miers, Edw. J., Malaysian Crustacea, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 459, 1880.

*Diagnosis.*—Dactylus of raptorial claw without teeth and dilated at base. Rostrum with a long slender acute median spine and subacute antero-lateral angles. Hind body wider than the carapace, with its sides straight and parallel. Second thoracic somite partially exposed dorsally. Lateral edges of all the abdominal somites with triangular marginal carinæ with the apices directed backwards. Dorsal surface of the thoracic and first five abdominal somites without carinæ or spines. Sixth abdominal somite with a short unarmed median carina, and three pairs of swollen convex lateral carinæ, all ending in spines, the second or intermediate shorter than the first and third. Telson ending in six acute spines with broad bases, each one with a broad convex longitudinal dorsal carina. Middle of dorsal surface of telson with a protuberant hemispherical eminence, upon which are five very broad convex carinæ, of which the median and submedian end posteriorly in acute spines, while the marginal ones are without spines and shorter than the others. There is a triangular subacute prominence on the anterior edge of the telson on each side, halfway between the middle line and the lateral margin, with a broad convex carina. Paddle of exopodite of uropod half as long as the second joint. Basal joint of uropod with two acute spines on dorsal surface, while its ventral prolongation ends in two nearly equal acute spines, with a rounded tooth on inner edge of outer one near the base. Tergal surfaces of the first five abdominal somites with longitudinal sutures on sides, and a transverse dorsal suture.

*General Description.*—Carapace flat, hind body convex, and highly polished.

[1] Brazilian Crustacea, *Trans. Conn. Acad.*, vol. ii. p. 31, 1869. [2] *Nouv. Arch. Mus. Hist. Nat.*, t. iv. p. 65, 1868.

Rostrum consisting of a transverse proximal portion more than twice as wide as long, with subacute antero-lateral angles, and a long slender median acute spine which reaches beyond the bases of the eyes (see fig. 6). Carapace nearly rectangular, three-fifths as long as wide, leaving the dorsal surface of the second thoracic appendage almost completely exposed, with broadly rounded antero-lateral and more acutely rounded postero-lateral angles. The antero-lateral angles project forwards beyond the median gastric area, which is very slightly convex and a little wider posteriorly than anteriorly, and bounded by two nearly straight gastric sutures which run from anterior to posterior edge. Transverse cervical suture almost invisible. Posterior edge of carapace transverse. Second thoracic somite as wide as carapace. The eight following somites equal in width, and wider ($\frac{179}{155}$) than the carapace. The lateral margins of the third thoracic somite are straight, with rounded angles, and as wide as the dorsal portion; the fourth is narrowed a little towards the lateral edge, and the fifth still more. There is a median impressed line on the dorsal surface of the third and one on the fourth thoracic somite. All the abdominal somites have marginal carinæ which are wide in front and gradually become narrow towards the postero-lateral angle, which is rounded in the first four segments, rectangular in the fifth, and ending in an acute spine in the sixth (see fig. 1). There are no dorsal carinæ on the first five abdominal segments. The sixth (see Pl. XIV. fig. 4) has a short unarmed median carina and three pairs of lateral carinæ, which terminate posteriorly in acute spines and are greatly swollen, so that they together occupy more than half the dorsal surface of the somite, convexly rounded, and widening anteriorly. The spines of the submedian and marginal carinæ project beyond the posterior edge of the somite, while those of the intermediate carinæ barely reach it. The second, third, fourth, and sixth abdominal somites are equal in length, and longer than the first and shorter than the fifth. A strongly impressed suture (see Pl. XIV. fig. 1) crosses the middle line of each of the first five abdominal somites near the posterior border, and bends forwards on the side of the somite, and each of these somites has also a lateral longitudinal suture on each side, branching upwards at its posterior edge.

The telson is considerably wider than long ($\frac{160}{145}$) and its dorsal surface is folded into a very graceful pattern which can hardly be satisfactorily described, although it can be understood by comparing the profile view, fig. 1, with the surface view shown in fig. 4. The median portion is occupied by a hemispherical prominence, upon which are five meridional carinæ, which are convexly rounded and so greatly swollen that they almost completely cover it. Three of these, the median and submedians, are abruptly rounded and emarginated at their posterior ends, where they end in acute spines, while the third or marginal pair do not end in spines and are much shorter.

On each side of the median prominence there is on the anterior edge of the telson a triangular prominence with a broad rounded subacute carina, and outside this, and near the antero-lateral angle, there is a transverse rounded prominence without a keel, and a

short transverse keel at the antero-lateral angle. The posterior edge of the telson is folded into six acute spines, and from the tip of each a broad convex carina runs forwards on the dorsal surface of the telson. The marginal carina reaches to the anterior border, the intermediate stops a little short of this border, and the third or submedian runs forwards for about half the length of the telson, where it abuts upon the median prominence.

The marginal spines of the telson have acute tips and swollen bases with convexly rounded outlines, and the deep sulci between them are bordered by convex ridges. The outer spine is simple; the intermediate has its outer edge simple and a secondary spine on its inner edge near its base; the submedian spine has a secondary spine on its outer edge near its base, and twelve or thirteen acute dentations on its inner edge. The dorsal surface of the basal joint of the uropod ends posteriorly in two acute spines, and there is a rounded lobe outside the base of the outer one; its ventral surface ends posteriorly in a process divided into two acute curved spines, the outer longer and with a rounded tooth near its base on its inner edge.

The paddle of the exopodite is more than half ($\frac{13}{22}$) as long as the second joint, which has a rounded process on the inner edge of its base, about twelve movable spines on its outer edge, and a ventral terminal immovable spine.

The eyes are cylindrical, with rounded corneæ (fig. 6), and the first and second antennæ are about equal in length. The eyes hide all the shaft of the first antenna except the terminal joint. The tip of the simple dactyle of the raptorial claw is curved outwards, and its inner edge is barbed with minute serrations.

The endopodite of the first abdominal appendage of the male (Pl. XV. fig. 8) is very similar to that of *Gonodactylus chiragra*. The terminal joint is divided by a deep marginal notch into a small outer lobe and a large inner lobe, both of which are rounded and not separated by a suture. The fixed limb *e* of the petasma is swollen at the base and it ends in a single acute hook.

*Remarks.*—Notwithstanding the fact that this is a widely distributed species, no minute description of it has been published, as Miers' description[1] gives little except the points of difference from *Gonodactylus chiragra*, and the only figure, the telson shown in Miers' fig. 9, is misleading, as will be seen by comparison with our fig. 4, Pl. XIV. In his figures, as well as in his descriptions, he represents the central area of the dorsal surface of the telson as made up of three pairs of curved carinæ on the sides of the median one, whereas more careful examination will show that the third or outermost pair do not belong to the central elevated convex system so characteristic of this and related species, but to a distinct eminence on the anterior edge of the telson.

This species is very closely related to *Gonodactylus chiragra*. The species next described, *Gonodactylus glabrous*, is in many respects intermediate between the two, the three forming a sharply defined natural group or subgenus. It may readily be

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xiv. p. 341, and ser. 5, vol. v. p. 120.

| Measurements of a male specimen from near Cape York. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tip of rostrum to middle of posterior edge of telson, | | 2·14 |
| Measurements on middle line:— | | |
| Rostrum, | ·15 | 70 |
| Carapace, | ·51 | 238 |
| Carapace, including rostrum, | ·66 | 308 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·14 | 65 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·10 | 47 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·10 | 47 |
| First abdominal somite, | ·12 | 56 |
| Second abdominal somite, | ·16 | 75 |
| Third abdominal somite, | ·16 | 75 |
| Fourth abdominal somite, | ·16 | 75 |
| Fifth abdominal somite, | ·20 | 93 |
| Sixth abdominal somite, | ·16 | 75 |
| Telson on middle line, | ·18 | 84 |
| Total length of hind body, | 1·48 | 692 |
| Total length on middle line, | 2·14 | 1000 |
| Total length of telson, | ·31 | 145 |
| Width of rostrum, | ·16 | 75 |
| Width of carapace between antero-lateral angles, | ·26 | 122 |
| Width of carapace (greatest), | ·33 | 155 |
| Width of third thoracic somite, | ·38 | 179 |
| Width of fourth thoracic somite, | ·38 | 179 |
| Width of fifth thoracic somite, | ·38 | 179 |
| Width of first abdominal somite, | ·38 | 179 |
| Width of second abdominal somite, | ·38 | 179 |
| Width of third abdominal somite, | ·38 | 179 |
| Width of fourth abdominal somite, | ·38 | 179 |
| Width of fifth abdominal somite, | ·38 | 179 |
| Width of sixth abdominal somite, between postero-lateral spines, | ·33 | 155 |
| Width of telson between submedian spines, | ·10 | 47 |
| Width of telson between intermediate spines, | ·26 | 122 |
| Width of telson (greatest), | ·34 | 160 |
| Length of paddle of exopodite of uropod, on dorsal surface, | ·13 | 61 |
| Width of second joint of exopodite of uropod, on dorsal surface, | ·22 | 103 |

distinguished from *Gonodactylus chiragra* by the presence of five instead of three carinæ on the median protuberance of the telson, and by the presence of acute spines on the posterior ends of three of them, by the possession of six instead of four spines on the posterior border, and by the presence of a tooth on the inner edge of the outer spine of the ventral prolongation of the uropod. It is more difficult to distinguish it from *Gonodactylus glabrous*, which it resembles very closely. The many minute differences will be pointed out in the description of this species.

*Colour.*—The alcoholic specimens have the carapace mottled with dark brown pigment, with four sharply defined dark spots close to its posterior edge, six elongated pigment spots on the third, six on the fourth, four on the fifth, and four on each of the first five abdominal somites. Miers says that his specimens from the Samoan Islands were dull olive green, with branchial appendages pink, but those colours are not preserved in the specimens which I have seen.

*Habitat.*—The Challenger collection includes two specimens, a male and a female, from 8 fathoms at Station 186, near Cape York, lat. 10° 30′ S., long. 142° 18′ E. Miers records it from Torres Straits and from other points in Northern Australia, as well as from the Red Sea, Ceylon, Gulf of Suez, Seychelles, Samoa Islands, Amboina, and other localities in the Indo-Pacific region.

*Size.*—Largest male specimen, $2\frac{14}{100}$ inches from tip of rostrum to middle of telson.

*Gonodactylus glabrous*, n. sp. (Pl. XIV. fig. 5; Pl. XV. figs. 7, 9).

*Diagnosis.*—Dactylus of raptorial claw without teeth, and dilated at base. Rostrum with a long slender acute median spine, and subacute lateral angles. Hind body wider than the carapace, with its sides straight and parallel. Second thoracic somite slightly exposed dorsally. Lateral edges of all the abdominal somites with triangular marginal carinæ with the apices directed backwards. Dorsal surfaces of the thoracic and first five abdominal somites without carinæ or spines. Sixth abdominal somite without a median carina, and with three pairs of lateral carinæ, all ending in spines, the submedian and intermediate being swollen and convex, while the marginal is more narrow and linear. The second or intermediate is shorter than the first and third. Telson ending in six acute spines with broad bases, and each with a sharply defined narrow longitudinal dorsal carina. Middle of dorsal surface of telson with a protuberant hemispherical eminence, upon which are five narrow sharply defined carinæ, of which the median and the two submedian end posteriorly in spines, while the marginal ones are without spines and shorter than the others. There is a triangular subacute prominence on the anterior edge of the dorsal surface of the telson on each side, halfway between the middle line and the lateral margin, with a narrow sharply defined carina. Paddles of exopodites of uropods less than half as long as the second joint. The basal joint of the uropod has only one acute spine on its dorsal surface, while its ventral prolongation ends in two nearly equal spines, with an obsolete rounded tooth on the inner margin of the outer one near its base. The tergal surfaces of the abdominal somites have no transverse or longitudinal sutures.

*General Description.*—This species is so very similar to *Gonodactylus graphurus* in every prominent characteristic that the description of that species will serve for this also,

except as regards the following features. The median spine of the rostrum of *Gonodactylus glabrous* reaches halfway to the tips of the eyes (see fig. 7). The carapace almost completely covers the fifth thoracic somite. The transverse cervical suture crosses the middle line of the carapace close to its posterior edge. The postero-lateral angles of the third and fourth as well as the fifth abdominal somite rectangular. The sixth abdominal somite has no median carina. The marginal carinæ of this somite are not swollen, and the intermediate and submedian carinæ are much less swollen than they are in *Gonodactylus graphurus*, especially towards their posterior ends (compare fig. 5 of Pl. XIV. with fig. 4). The abdominal somites have no transverse or longitudinal sutures. The telson is nearly ($\frac{1}{1}\frac{4}{5}\frac{6}{1}$) as long as wide, and its various dorsal carinæ are all of them more sharply defined than they are in *Gonodactylus graphurus*, as will be seen by comparing fig. 5 with fig. 4, and they are very little or not at all swollen, so that the exposed spaces on the dorsal surface of the telson, between the carinæ on the median elevation as well as those between the carinæ on the lateral portions of the telson, are much wider than the carinæ themselves. The outlines of the bases of the marginal spines of the telson are nearly straight, and they lack the swelling convex curves of the graceful outline of the telson of *Gonodactylus graphurus*. The dorsal surface of the basal joint of the uropod has only one acute spine, and the paddle of the exopodite is considerably less than half ($\frac{1}{2}\frac{2}{8}$) as long as the second joint, when measured on the dorsal surface. The tip of the second joint of the first antenna is exposed in front of the eye. In all other respects the species conforms to the general description of *Gonodactylus graphurus*.

*Locality.*—The Challenger collection contains one female specimen from Samboangan Reefs.

*Size.*—The total length from the tip of the rostrum to the middle point of the posterior edge of the telson is $2\frac{5}{100}$ inches.

*Colour.*—In the alcoholic specimen there is much less pigment than there is in *Gonodactylus graphurus*, and this is restricted to small sharply-defined symmetrical eye-like black spots, of which there are six in the cardiac area of the carapace, two on the sixth, and two on the seventh thoracic somite, four on the eighth, and six on each of the first five abdominal somites.

*Remarks.*—This species may be recognised by its very close and striking resemblance to *Gonodactylus graphurus*, from which it may be distinguished without difficulty by the absence of sutures on the abdominal terga, by the absence of a median dorsal carina on the sixth abdominal somite, as well as by the fact that all the dorsal carinæ on this somite and on the telson are more sharply defined and less swollen and rounded than they are in this species.

While it is a little closer than *Gonodactylus graphurus* to *Gonodactylus chiragra*, there is little difficulty in distinguishing it from the latter species by the presence of six well-developed marginal spines upon the telson, and of four carinæ upon the central

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length of female specimen from Samboangan Reefs, | 2·05 | |
| Measurements on middle line :— | | |
| Rostrum, | ·17 | 83 |
| Carapace, | ·51 | 249 |
| Carapace, including rostrum, | ·68 | 332 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·10 | 49 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·10 | 49 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·10 | 49 |
| First abdominal somite, | ·12 | 59 |
| Second abdominal somite, | ·13 | 63 |
| Third abdominal somite, | ·13 | 63 |
| Fourth abdominal somite, | ·13 | 63 |
| Fifth abdominal somite, | ·18 | 88 |
| Sixth abdominal somite, | ·16 | 78 |
| Telson on middle line, | ·22 | 107 |
| Total length of hind body, | 1·37 | 668 |
| Total length on middle line, | 2·05 | 1000 |
| Greatest length of telson, | ·30 | 146 |
| Width of rostrum, | ·15 | 73 |
| Width of carapace at antero-lateral angles, | ·25 | 122 |
| Width of carapace (greatest), | ·35 | 171 |
| Width of third thoracic somite, | ·39 | 190 |
| Width of fourth thoracic somite, | ·39 | 190 |
| Width of fifth thoracic somite, | ·39 | 190 |
| Width of first abdominal somite, | ·39 | 190 |
| Width of second abdominal somite, | ·39 | 190 |
| Width of third abdominal somite, | ·39 | 190 |
| Width of fourth abdominal somite, | ·39 | 190 |
| Width of fifth abdominal somite, | ·39 | 190 |
| Width of sixth abdominal somite between postero-lateral spines, | ·32 | 156 |
| Width of telson between submedian spines, | ·08 | 39 |
| Width of telson between intermediate spines, | ·22 | 107 |
| Width of telson (greatest), | ·31 | 151 |
| Length of paddle of exopodite of uropod on dorsal surface, | ·12 | 58 |
| Length of second joint of exopodite of uropod on dorsal surface, | ·28 | 137 |

prominence, which is more protuberant both in *Gonodactylus glabrous* and in *Gonodactylus graphurus* than it is in *Gonodactylus chiragra.*

The very close resemblance between the three species shows their close relationship, and it is quite possible that future discoveries may reveal so many transitional forms that the sharp lines between the species will break down, but in the present state of our knowledge of the group I think we are compelled to recognise the three as distinct species.

## Genus *Protosquilla*, n. gen. (Pl. XVI.).

*Diagnosis.*—Small Stomatopoda with the sixth abdominal somite more or less completely fused with the telson; the rostrum furnished with long acute median and antero-lateral spines; the dactylus of the raptorial claw dilated at the base, and without marginal spines, the eyes, antennary scales, and uropods small, and the hind body convex. Ontogeny unknown.

*General Description and Remarks.*—The following small but very interesting and remarkable Stomatopoda are very slightly known, and most of the species have, on account of the absence of spines on the dilated dactylus of the raptorial claw, been placed by various authors in Latreille's genus *Gonodactylus*, although they resemble each other in many features which are also points of difference from *Gonodactylus* as well as from all other Stomatopoda.

While it is also true that they differ greatly among themselves, it is not difficult to discover a common type of structure which runs through them all, and which should find its expression in our system of classification. I therefore place them in a distinct genus, and as many of their distinctive characteristics, such as the small size of their antennary scales and uropods, the great length of the acutely pointed rostrum, and the union of the sixth abdominal somite with the telson, are points of resemblance to the Stomatopod larva, I propose for the genus the name *Protosquilla*. This name is the more appropriate inasmuch as all the other Stomatopoda present evidences of divergent descent from a common stem form, which, like the living representatives of the genus *Protosquilla*, was characterised by the small size of its eyes, antennary scales, and uropods. In this genus the dactylus of the raptorial claw is dilated at the base, with microscopic serrations, but no spines, on its inner margin; the rostrum has a long slender acute median spine, and one or more pairs of acute antero-lateral spines; the eyes are small and subcylindrical; the carapace is smooth and flat, with well-marked longitudinal sutures, but with the transverse cervical suture obsolete; the hind body is convex, without dorsal carinæ on the first four terga, with its posterior end curved downwards, and with the sixth abdominal somite more or less completely fused with the telson. The telson and sixth abdominal somite differ in texture from the general surface of the body, and are often remarkably and elegantly ornamented; the telson is usually wider than long, and its marginal spines are pushed backwards, and are either obsolete or else developed in a remarkable manner. The eyes, antennary scales, and uropods are very small, and the prolongation from the ventral surface of the basal joint of the uropod ends in two short stout spines.

All but three of the following species are known to exhibit all of these characteristics, and while the published accounts of those three are so incomplete as to leave many points in uncertainty, the close general resemblance between them and the better known species indicates that future research will show that they share all the characteristics of the genus.

As regards one of the most remarkable peculiarities of the genus, the pushing backwards of the marginal spines of the telson, the various species present a most interesting series of steps in the process of modification. In *Protosquilla folinii*[1] the outline of the telson closely approximates the prevalent type among the Stomatopoda. There are six marginal spines, and the submedians, which project furthest backwards, are separated by a well-marked median notch, while the second pair are a little more anterior, and the third pair still more so, all the marginal spines, however, being further back than they are in ordinary Stomatopods. In the very closely related species, *Protosquilla elongata*, Pl. XV. fig. 2, all the spines are fused into a pair of rounded lobes on the sides of the median notch, and no traces of the separate spines are visible in a dorsal view, although their rounded ends project slightly below the general surface of the ventral side of the telson, as shown in fig. 12.

In *Protosquilla trispinosa* (*Gonodactylus trispinosus*, Miers, Squillidæ, pl. iii. fig. 10) the median notch is faintly indicated, and all the spines are on the convexly rounded posterior border of the telson. In *Protosquilla cerebralis* (Pl. XVI. fig. 2) the telson is transversely truncated behind, and the spines are all on its posterior edge. In *Protosquilla excavata* (*Gonodactylus excavatus*, Miers, Squillidæ, pl. iii. fig. 12) the spines are obscurely indicated, but the lateral ones are now the longest, and the edge of the telson is deeply excavated between them, while in *Protosquilla furcicaudata* (*Gonodactylus furcicaudatus*, Miers, Squillidæ, pl. iii. fig. 14) this excavation is carried so far that the median portion of the telson has disappeared, and the two marginal spines have approached each other on the middle line, evidently as the result of an infolding of the median portion of the posterior edge of the telson of the larva. In *Protosquilla guerinii* (Pl. XVI. fig. 1), the marginal spines have undergone a very remarkable modification in a somewhat divergent direction. They are on the posterior edge, and the laterals project as far backwards as the submedians, but they have become greatly divided, forming a complicated pectinated structure.

As regards the telson, *Protosquilla folinii* is at one end of a series at the other end of which is *Protosquilla furcicaudata*, but it is difficult to decide which of these forms is the one in which the process of modification began. As the telson is long, with a convex border, in most Malacostraca, and in the Stomatopod larva, it is probable that *Protosquilla folinii* is the primitive form, and *Protosquilla furcicaudata* a highly modified form, and that the relationship to the other Stomatopoda is through *Protosquilla folinii*, which must therefore be regarded as one of the closest living allies of the ancestral type of the order.

Outside the genus *Protosquilla;* the two species for which I have proposed to establish the genus *Coronida*, *Coronida bradyi* and *Coronida trachura*, are very similar to *Protosquilla*, as are also, but in a less degree, the true *Gonodactyli*. On account of the

[1] *Gonodactylus folinii*, A. Milne-Edwards, *Nouv. Arch. Mus. Hist. Nat.*, t. iv., pl. xviii. fig. 10.

great interest of this genus, I give, in addition to the descriptions of the species which are represented in the Challenger collection, brief diagnoses of the other known species.

1. *Protosquilla elongata*, n. sp. (Pl. XV. figs. 2, 12; Pl. XVI. fig. 4).

*Diagnosis.*—*Protosquilla* with the median spine of the rostrum long and slender, and the antero-lateral spines bifurcated at the tips. Carapace elongated, two-thirds as wide as long, with antero-lateral angles acute. Second thoracic somite exposed and subacute laterally. Hind body wider than carapace. Lateral angles of third, fourth, and fifth thoracic somites nearly straight, with rounded angles. Sixth abdominal somite with a thickened transverse ridge along its posterior border, from which four thickened carinæ, two submedian and two submarginal, run forwards to the anterior edge of the somite, the two outer carinæ being obscurely divided into three lobes. Suture between sixth abdominal somite and telson distinct but immovable.

Telson a little wider than long, with a thickened median carina, and on each side of this a very wide and prominent curved lateral carina. Telson with a deep notch on the middle line behind, and on each side of this an obtusely rounded lobe, the outline of which is continuous in a dorsal view, but with traces of three marginal spines on the ventral surface. Endopodite of uropod triangular. First antennæ short. An acute spine on anterior edge of first joint of second antenna.

*General Description.*—Median spine of rostrum slender and acute, slightly dilated at base, and reaching nearly to the tips of the eyes, which are cylindrical, with the corneal portion inclined backwards externally. Antero-lateral angles of rostrum long, acute, curved forwards, and divided at the tip into two spines one above the other. Carapace narrower than hind body, much longer ($\frac{22}{15}$) than wide, and slightly emarginated. The antero-lateral angles ending in short spines, the postero-lateral angles rounded. Gastric area distinct, rectangular, slightly convex, with gastric suture continued nearly straight to posterior edge. Second thoracic somite exposed, narrow, and subacute at lateral edges. The following thoracic somites wider than the carapace and nearly as wide as the hind body. The lateral edge of the third is longitudinally truncated, that of the fourth obliquely truncated, so that the somite is wider at the antero-lateral than at the postero-lateral angle. The fifth is produced into a subacute lobe. First five abdominal somites smooth dorsally, and almost but not quite equal in width; the width of the first being $\frac{162}{1000}$, and that of the fifth $\frac{184}{1000}$, of the total length. The postero-lateral angles of the abdominal somites are subacute. The sixth abdominal somite is immovably united to the telson, but the suture is distinct. The posterior edge of the dorsal surface is elevated into a thick, obscurely defined, rounded transverse ridge, from which

four thickened carinæ run forwards nearly to the anterior edge of the somite, separated from each other by interspaces which are about equal to the ridges in width.

The two submedian carinæ are nearly parallel and longitudinal, while the two outer or submarginal ones diverge anteriorly, and have their inner edge obscurely divided into three rounded lobes. The telson is deeply notched on the middle line, and is slightly wider than long. In a ventral view (Pl. XV. fig. 12) each of the rounded lobes which borders the median notch is seen to consist of three marginal spines, crowded backwards, but with the submedian longest, the intermediate shorter, and the external shortest. No trace of these spines is visible in a dorsal view, and the dorsal outline of the telson consists of a single obtusely rounded lobe on each side of the triangular median notch, which is fringed with hairs.

The middle of the dorsal surface of the telson is occupied by a broad wedge-shaped median ridge or carina, which is wide anteriorly and narrows posteriorly to a rounded point which is scarcely elongated above the general surface of the telson. This carina is surrounded on all sides, except at its anterior end, by a depression or groove, outside which there is on each side a greatly thickened submedian carina or ridge, the general course of which is longitudinal, although it is slightly curved, with the convexity away from the middle line.

The tips of the extended uropods reach nearly as far backwards as the telson. The paddle of the exopodite is very small, that of the endopodite longer and nearly triangular. The basal joint has a single acute spine on its dorsal surface, and the two ventral spines are short and stout, the outer being the larger and longer.

The eyes are cylindrical, with the convex curved portion obliquely placed and running backwards on the outside of the base. The ocular segment is exposed, broad, and deeply notched on the middle line under the median spine of the rostrum. The antennæ are short, and the basal joint of the second ends in an acute spine. The dactylus of the raptorial claw is greatly swollen at the base, with a deep notch on its outer edge. The tip of the dactylus is gently and regularly curved to the acute point, and its inner edge is barbed with minute serrations, nearly to the base. The edge of the second joint is bordered by minute dentations.

The exposed thoracic legs are long and slender.

The dorsal surface of the body, with the exception of the sixth abdominal somite and telson and uropod, is highly polished, while these are rough.

*Habitat.*—One female specimen from St. Vincent, Cape Verde Islands.

*Colour.*—In the alcoholic specimen the telson and sixth abdominal somite and uropods are dirty-white, while the rest of the body is highly polished and very dark brown, except a transverse strip of light yellowish-brown across the carapace, posterior to the middle point of its length, and a corresponding light band across the enlarged joint of the second maxilliped.

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| On middle line :— | | |
| Rostrum, | ·07 | 91 |
| Carapace, | ·17 | 221 |
| Carapace, including rostrum, | ·24 | 312 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·042 | 55 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·043 | 56 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·042 | 55 |
| First abdominal somite, | ·043 | 56 |
| Second abdominal somite, | ·043 | 56 |
| Third abdominal somite, | ·052 | 68 |
| Fourth abdominal somite, | ·060 | 78 |
| Fifth abdominal somite, | ·073 | 95 |
| Sixth abdominal somite, | ·057 | 74 |
| Telson on middle line, | ·072 | 94 |
| Length of hind body, | ·527 | 687 |
| Total length on middle line, | ·767 | 999 |
| Greatest length of telson, | ·10 | 130 |
| Width of carapace between antero-lateral spines, | ·092 | 120 |
| Width of carapace (greatest), | ·115 | 149 |
| Width of third thoracic somite, | ·128 | 165 |
| Width of first abdominal somite, | ·125 | 163 |
| Width of fifth abdominal somite, | ·141 | 184 |

*Size.*—Length, $\frac{77}{100}$ inch.

*Remarks.*—A comparison of this species with the descriptions of *Gonodactylus folinii* which are given by A. Milne-Edwards [1] and Miers [2] would at first sight seem to indicate that they are the same as this species, as there is a very close general resemblance, as well as an almost perfect agreement in size, and Milne-Edwards' single specimen was obtained at St. Vincent, the place where the Challenger specimen was collected. Neither of these authors notices the bifurcation of the antero-lateral spines of the rostrum, the elongation of the carapace or the spines at its antero-lateral angles, but as these points might easily have been overlooked on account of the great minuteness of the specimens, I was at first inclined to believe that they are the same, but careful examination of Milne-Edwards' figures brings out so many important points of difference that I am forced to conclude that there are at St. Vincent two closely related species of this minute type, or else that the figures which are given by Milne-Edwards are so inaccurate as to be of no value. Which of these alternatives is the true one can be decided only by renewed examination, and as our specimen differs very essentially from

[1] *Nouv. Arch. Mus. Hist. Nat.*, t. iv. p. 65. [2] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. v. p. 123.

Milne-Edwards' figures of *Gonodactylus folinii*, and as it also fails to agree perfectly with his and Miers' descriptions, it must for the present at least be regarded as a distinct species, differing from *Protosquilla* (*Gonodactylus*) *folinii* in the following points:—Antero-lateral angles of rostrum simple in *Protosquilla folinii*, double in *Protosquilla elongata*. Posterior margin of telson with three rounded spines on each side of the deep median notch in *Protosquilla* (*Gonodactylus*) *folinii*, and a single obtusely rounded lobe in *Protosquilla elongata*.

If A. Milne-Edwards' figures are trustworthy the two species also differ in the following features:—First antennæ very long in *Protosquilla folinii*, short in *Protosquilla elongata*. No spine on anterior edge of basal joint of second antenna in *Protosquilla folinii*, a long spine in *Protosquilla elongata*. Carapace nearly as wide as long, rectangular, and with rounded antero- and postero-lateral angles in *Protosquilla folinii*; elongated, emarginated, narrow anteriorly, and with antero-lateral angles acute in *Protosquilla elongata*. Thoracic and abdominal somites rounded in *Protosquilla folinii*; lateral margins of thoracic somites of *Protosquilla elongata* truncated, and postero-lateral angles of abdominal somites acute.

The species is of great interest as it and the closely related *Protosquilla folinii* are the most primitive forms which are known among the Stomatopods, exhibiting the embryonic or larval features which are characteristic of the genus, such as the fusion of the telson with the sixth abdominal somite, the small size of the uropods, and the presence of three long spines on the rostrum; without exhibiting any of the remarkable modifications of the posterior end of the body which are so strikingly characteristic of most of the species of the genus. The telson of an ordinary *Squilla*, that of *Coronis*, or that of the most aberrant *Protosquilla*, such as *Protosquilla guerinii*, may all be derived from that of *Protosquilla folinii* by very slight changes, and the carapace of *Protosquilla elongata* might be readily modified into that of a true *Squilla*, while it is also very similar to the flat square carapace of the other members of its own genus.

2. *Protosquilla folinii* (Milne-Edwards).

*Gonodactylus folinii*, A. Milne-Edwards, Obs. sur la Fauna Carcinol. des Iles du Cap-Vert, Nouv. Arch. Mus. Hist. Nat., t. iv. 1868, p. 65, pl. xviii. figs. 8–11.

*Gonodactylus Folinii*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 123.

*Diagnosis.*—*Protosquilla* with the rostrum ending in a long slender acute median spine, and on each side of this a single acute antero-lateral spine which is directed outwards and forwards and is a little shorter than the median spine. Carapace with rounded antero- and postero-lateral angles. First five abdominal somites smooth, Dorsal surface of sixth abdominal somite with four rounded tubercles, the outer ones

three-lobed. Dorsal surface of telson with a broad unarmed median ridge, and on each side of this a more protuberant longitudinal and somewhat uniform prominence, which is convex on its lateral or external side, and concave towards the middle line. The telson has a median notch on its posterior edge, and on each side of this there are three obtuse rounded marginal spines, of which the submedian is farthest back, and the lateral most anterior.

*Length.*—About three-fourths of an inch.

*Habitat.*—A. Milne-Edwards records a single specimen of this species from St. Vincent, and Miers a single male from Mauritius, and two small specimens, without record of locality, from the "Herald" collection.

*Remarks.*—In Milne-Edwards' figures the carapace is represented rounded at its anterior as well as at its posterior angles, and nearly rectangular, and the fifth thoracic somite is represented with rounded lateral edges, as are all the other thoracic and abdominal somites.

In my remarks on *Protosquilla elongata* I have given my reasons for regarding that species as distinct from this one.

3. *Protosquilla trispinosa* (White).

*Gonodactylus trispinosus*, White, List Crust. Brit. Mus., 1847, p. 85.
*Gonodactylus trispinosus*, Dana, J. D., U.S. Explor. Exped., Crustacea, i. p. 623, 1852.
*Gonodactylus trispinosus*, Heller, C., Reise der Novara, 1868, Crustacea, p. 126.
*Gonodactylus trispinosus*, Miers, E. J., Cat. New Zealand Crust., 1876, p. 126.
*Gonodactylus trispinosus*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 121, pl. iii. fig. 10 (telson).
*Gonodactylus trispinosus*, Miers, E. J., Malaysian Crustacea, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 460.

*Diagnosis.*—*Protosquilla* with the two antero-lateral spines of the rostrum nearly as long as the median spine. The carapace is long, and nearly rectangular, with nearly rectangular antero- and postero-lateral angles. The fifth abdominal somite is longitudinally corrugated. The sixth is immovably united to the telson, although the suture is clearly indicated; its dorsal surface is marked by six smooth rounded tubercles. On the dorsal surface of the telson there are three smooth rounded tubercles disposed in a triangle, with the median one anterior to the two laterals. The posterior margin is slightly notched in the middle, and is armed with very minute spines.

*Size.*—About one and one half inches long.

*Habitat.*—Fiji Islands, Dana; Auckland, Heller; Mauritius, ? Hoffmann; Swan River, Australia, Miers; Shark's Bay, Australia, Miers; Amboina, Miers; Ceylon, Miers (var. *pulchella*).

*Remarks.*—According to Heller's description the telson is rectangular and is armed

with four marginal spines, while Miers represents it as broadly rounded posteriorly and armed with six minute marginal spines. It therefore seems possible that there may be two closely related forms instead of a single species.

Although this species is much better known than any other *Protosquilla* no figure has ever been published except the drawing of the telson given by Miers. A minutely accurate figure of the entire animal is very much needed. All the specimens the sex of which is given are males, except the single female recorded by Miers from Amboina.

4. *Protosquilla cerebralis*, n. sp. (Pl. XIV. figs. 2, 3; Pl. XVI. figs. 2, 3).

*Diagnosis.*—*Protosquilla* with the body almost uniform in width from the anterior edge of the carapace to the posterior edge of the telson. The two slender acute antero-lateral spines of the rostrum are nearly as long as the acute median spine. The carapace is rectangular, with rounded angles, and the fifth thoracic somite is slightly exposed dorsally. No dorsal carinæ on the carapace or on the first seven exposed somites. Lateral processes of the sixth and seventh thoracic somites longer than those of the eighth, and rounded. Postero-lateral angles of all the abdominal somites obtuse. Dorsal surface of fifth abdominal somite with a median thickened carina, and, on each side of this numerous sublongitudinal ridges, converging posteriorly. Sixth abdominal somite immovably fused with the telson and ornamented by swollen convoluted ridges symmetrically arranged in a complex pattern. Telson nearly twice as wide as long, deeply notched on the middle line behind, with its posterior margin rounded and ending in three pairs of short acute spines. Dorsal surface of the telson sculptured in a complicated symmetrical convoluted pattern, consisting of a very complex central pattern which is subtriangular and divided into five principal convolutions; two submedian convex oval convoluted lobes, and a number of parallel longitudinal lateral ridges. Dactylus of raptorial claw greatly swollen at base.

*General Description.*—The median spine of the rostrum is slender, acute, longer than the antero-lateral spines, and reaching about halfway to the tips of the eyes, which are subcylindrical, with the corneal portion inclined backwards externally. The antero-lateral spines of the rostrum are slender and acute. The flat carapace is a little longer than wide, slightly narrower than the exposed thoracic somites, and nearly rectangular with the antero- and postero-lateral angles, rounded and nearly alike. The two longitudinal sutures are prominent and continuous from the anterior to the transverse posterior edge, and there is a faintly marked transverse cervical suture. The sixth and seventh thoracic somites are wider than the eighth, and their lateral edges are produced backwards and rounded, as seen from above, while in profile the anterior angle is obtuse and the posterior one nearly a right angle. The middle of the lateral edge of the eighth is produced into a subacute lobe over the basal joint of the appendage. The eighth is a

little longer and narrower than the sixth and seventh thoracic somites, and a little shorter than the first four abdominal somites, which are about equal in length, as wide as the sixth and seventh thoracic, smooth on the dorsal surfaces, and with marginal keels or ridges on their lateral edges, the postero-lateral angles of which are nearly right angles. The fifth abdominal somite is longer than, and quite different from, those in front of it, as its dorsal surface is sculptured by numerous sublongitudinal ridges symmetrically arranged on each side of a broad median ridge or carina. The ridges are not quite as long as the somite, which has along its anterior and posterior borders smooth bands which are not broken into ridges. The lateral ridges are slightly convergent towards the posterior edge, and their anterior ends are lobed and sometimes irregularly forked. The sixth abdominal somite is shorter on the middle line than at the edges and immovably fused with the telson which is transverse, and nearly twice as wide as long. The posterior end of the body is bent downwards, so that the dorsal surface of the telson faces backwards. The sixth abdominal somite is sculptured in a symmetrical pattern of broad convoluted ridges and tubercles, which are so closely crowded together that the dorsal surface is almost covered with them. The dorsal surface of the telson is also sculptured in a complicated pattern, in which six elements may be recognised, first, a transverse ridge lobed on its posterior edge running along the anterior border of the telson; second, a triangular median area, the broad anterior end of which is elevated above the general surface of the telson, while its narrow posterior portion is sunk between two lateral elevations. The median area is convoluted and divided into five lobes, a median anterior, two antero-laterals which are again subdivided, and two posterior lobes or ridges, one of which runs backwards on each side of the deep narrow postero-median notch; third, on each side of the median area an elongated oval elevated area, which is divided into halves by a longitudinal furrow, and also divided by lateral furrows into a number of secondary lobes; fourth, three thickened longitudinal marginal keels on each side external to the oval elevation. The six short acute marginal spines are crowded together in two sets, on the posterior edge of the telson, with a broad space fringed with small spines between the submedians.

The uropods are small, and the basal prolongation (Pl. XVI. fig 3) ends in two short stout acute spines, the outer larger and longer than the inner, and with a slight enlargement on its inner edge. The row of marginal spines, about ten in number, on the outer edge of the second joint of the exopodite curves upwards on to the dorsal surface at its proximal end. The inner edge of the dactylus (Pl. XIV. fig. 3) of the raptorial claw is finely serrated, and the basal enlargement on the outer edge is semi-circular, abruptly limited distally, and indented on its outer margin.

*Size.*—The length of the single specimen is $1\frac{27}{100}$ inches from the tip of the rostrum to the middle line of the telson.

*Habitat.*—The single female specimen is from the reefs at Levuka, Fiji.

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Total length from tip of rostrum to tip of telson on middle line, | 1·27 | |
| Rostrum, | ·08 | 62 |
| Carapace, | ·30 | 234 |
| Carapace including rostrum, | ·38 | 296 |
| From posterior edge of carapace to posterior edge of third thoracic somite, | ·05 | 39 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·06 | 47 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·08 | 62 |
| First abdominal somite, | ·10 | 78 |
| Second abdominal somite, | ·09 | 70 |
| Third abdominal somite, | ·09 | 70 |
| Fourth abdominal somite, | ·12 | 93 |
| Fifth abdominal somite, | ·13 | 101 |
| Sixth abdominal somite, | ·07 | 55 |
| Telson on middle line, | ·10 | 78 |
| Total length of hind body, | ·89 | 673 |
| Total length on middle line, | 1·27 | 969 |
| Greatest length of telson, | ·14 | 109 |
| Width of carapace between antero-lateral angles, | ·18 | 140 |
| Width of carapace (greatest), | ·23 | 179 |
| Width of third thoracic somite, | ·25 | 195 |
| Width of fourth thoracic somite, | ·26 | 199 |
| Width of fifth thoracic somite, | ·24 | 187 |
| Width of first abdominal somite, | ·27 | 210 |
| Width of second abdominal somite, | ·27 | 210 |
| Width of third abdominal somite, | ·27 | 210 |
| Width of fourth abdominal somite, | ·27 | 210 |
| Width of fifth abdominal somite, | ·27 | 210 |
| Width of sixth abdominal somite, | ·26 | 199 |
| Width of telson between postero-median spines, | ·08 | 62 |
| Width of telson (greatest), | ·26 | 199 |
| Length of paddle of exopodite of sixth abdominal appendage, | ·06 | 47 |
| Length of second joint of exopodite of sixth abdominal appendage, | ·10 | 78 |
| Length of endopodite of exopodite of sixth abdominal appendage, | ·10 | 78 |
| Distance between tips of sixth abdominal appendage, | ·57 | 444 |
| Length of first antenna, measured from tip of rostrum, | ·35 | 273 |
| Length of flagellum of second antenna, | ·20 | 156 |
| Length of scale of second antenna, | ·13 | 101 |
| Length of eye, | ·09 | 70 |

*Colour.*—The fifth and sixth abdominal somites and the telson and uropods of the alcoholic specimen are colourless and rough, while the rest of the body is highly polished, and mottled with brown pigment.

*Remarks.*—The only species which is at all similar to this is Wood-Mason's *Gonodactylus glyptocercus* from the Nicobars, but his description, which is given below, is so

brief and imperfect that it is impossible to decide how closely related these two are. They may be the same species, but so far as the description shows, it is quite possible that the resemblance is a superficial one only, and that they are not at all similar in their essential characteristics.

5. *Protosquilla glyptocerca* (Wood-Mason).

*Gonodactylus glyptocercus*, Wood-Mason, Proc. Asiatic Soc. Bengal, p. 232, 1875.
*Gonodactylus glyptocercus*, Wood-Mason, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 263, 1876.
*Gonodactylus glyptocercus*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 123, 1880.

In his description of this species, which is very brief, he does not say whether the sixth abdominal somite is fused with the telson. It is possible that it is not related in any way to the species of *Protosquilla*, but I place it here provisionally as the only points he mentions show a striking likeness to *Protosquilla cerebralis*, with which it may possibly be identical.

His short notice simply says that it is like *Gonodactylus trispinosus*, but that the terminal post-abdominal somite is ornamented with two oval tubercles, bounded by an impressed inverted line, and with a medium cinquefoil-shaped one, and the two preceding segments symmetrically engraved with fine lines.

6. *Protosquilla guérinii* (White) (Pl. XVI. figs. 1 and 6.)

*Gonodactylus guérinii*, White, A., New Crustacea, Proc. Zool. Soc. Lond., January 22, 1861, p. 43, pl. vii.
*Gonodactylus guérinii*, White, A., Ann. and Mag. Nat. Hist., vol. vii., 1861, p. 476.
*Gonodactylus guérinii*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 121.

*Diagnosis.—Protosquilla* with eyes slightly enlarged at tips, carapace as wide as long. Second thoracic somite exposed. First five abdominal somites with marginal carinæ. Fifth abdominal somite with several transverse rows of short acute dorsal spines on its posterior half. Sixth abdominal somite covered on its dorsal surface with numerous long spines. Posterior edge of telson with two pairs of marginal spines projecting backwards. The submedian with a single row of secondary spines on each side, and the laterals with a single row on the inner and a double row on the outer edge, running from its tip along the outer edge of the telson to its anterior end. Dorsal surface of telson with twenty-two long spines symmetrically arranged. Second joint of exopodite of uropod nearly three times as long as paddle. Dilated base of dactylus of raptorial claw truncated on its outer edge, and not notched. Endopodite of uropod with five spines on its dorsal surface.

*General Description.*—The Challenger collection contains one female specimen from Honolulu of this species, which has previously been represented by the single specimen which was obtained by the "Herald" from Matuku, Fiji Islands. It may be distinguished without difficulty from all other known Stomatopods, except A. Milne-Edward's *Squilla brady*, by the long spines which cover the telson and sixth abdominal segment, and from this species by the length of the median spine of the rostrum, and the absence of spines on the inner edge of the dactyle of the raptorial claw.

Transverse diameter of rostrum about equal to its length; antero-lateral spines of rostrum acute, but very slightly produced forwards, and shorter than the median spine, which ends in an acute point opposite the middle of the eye. The carapace is nearly square, as long as wide, slightly narrowed anteriorly, and with antero- and postero-lateral angles rounded and alike. The gastric area is slightly convex and its lateral sutures are sharply defined, while the transverse cervical suture is almost obsolete. Carapace wider than thoracic region, and about as wide as the abdomen. First thoracic somite exposed and subacute at lateral edges. Third, fourth, and fifth thoracic somites so articulated as to form a convex dorsal protuberance. Lateral edges of third and fourth obliquely truncated converging posteriorly, with rounded angles. Lateral edges of fifth subacute. The abdomen increases slightly in width from in front backwards, but not so rapidly as in White's figure. The abdominal somites have faintly marked marginal carinæ or ridges, and the first four have on each side, at about one-third of the distance from the lateral edge to the middle line, a small sharply defined indentation. The sixth abdominal somite is immovably united to the fifth as well as to the telson, although the sutures are distinctly visible. The first four abdominal somites are smooth dorsally, as is also the anterior half of the fifth, a transverse line separating it from the posterior half, which is armed by about six transverse rows of numerous short spines, which increase in length and in the definiteness of the transverse rows as they approach the posterior margin of the somite. The dorsal surface of the sixth abdominal somite is armed with very numerous (about fifty-six) long cylindrical spines, each of which ends in a blunt rounded tip with a perforation from which a soft tubular fleshy process protrudes. Eight of these spines are arranged in a transverse line along the posterior border of the somite, and are arranged symmetrically in pairs with reference to the middle line, about twenty more form an anterior transverse band which, starting at the postero-lateral angle, runs obliquely forwards to the anterior edge of the somite, along which it is continued across the middle line. The triangular antero-lateral area, external to this line, is occupied by about fourteen crowded spines on each side.

The suture between this somite and the telson is distinct, but immovable, and bordered by a raised ridge.

The central area of the telson is occupied by twenty-two similar long spines, with fleshy appendages, symmetrically arranged with reference to the middle line, and so

| Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| On middle line. | | |
| Rostrum, | ·07 | 62 |
| Carapace, | ·23 | 205 |
| Carapace including rostrum, | ·30 | 267 |
| From posterior edge of carapace to posterior edge of third tharacic somite, | ·05 | 45 |
| From posterior edge of third to posterior edge of fourth thoracic somite, | ·07 | 62 |
| From posterior edge of fourth to posterior edge of fifth thoracic somite, | ·09 | 81 |
| First abdominal somite, | ·07 | 62 |
| Second abdominal somite, | ·08 | 72 |
| Third abdominal somite, | ·07 | 62 |
| Fourth abdominal somite, | ·08 | 72 |
| Fifth abdominal somite, | ·11 | 98 |
| Sixth abdominal somite, | ·05 | 45 |
| Telson on middle line, | ·15 | 134 |
| Total length of hind body, | ·82 | 733 |
| Total length on middle line, | 1·12 | 1000 |
| Telson to tips of spines, | ·24 | 234 |
| Width of carapace between antero-lateral spines, | ·19 | 169 |
| Width of carapace (greatest), | ·24 | 234 |
| Width of fourth thoracic somite, | ·20 | 178 |
| Width of first abdominal somite, | ·21 | 187 |
| Width of fifth abdominal somite, | ·25 | 223 |
| Width of telson between bars of lateral spines, | ·28 | 249 |
| Width of telson between tips of lateral spines, | ·17 | 151 |

placed that they fall into rows longitudinally and transversely. Two are on the middle line, and the others in pairs. There are five in the first transverse row, six in the next, two in the third, five in the fourth, and four in the last. The free edge of the telson carries two pairs of primary marginal spines which are pushed back into the posterior border. The submedians are slightly longest, acute, separated by a deep median notch, and with twelve long acute secondary spines on their inner and nine on their outer edge. The two lateral spines are also acute, and have six acute long secondary spines on their inner edge, and on their outer edge very numerous (twenty-four or more) long spines placed in two rows, one above the other, and running along the outer edge of the telson to its anterior end.

The uropods are very short and small; the paddle of the endopodite is elongated oval with five acute immovable spines placed in a longitudinal row on its dorsal surface, the paddle of the exopodite is very small, the second joint long with eight movable spines on its outer edge. The spines on the basal prolongation are short and acute, and the inner one very much shorter and more slender than the outer one.

The basal enlargement on the dactyle of the raptorial claw is not notched, its outer border is truncated, and at its distal edge the transition is abrupt to the long slender gently curved acute tooth, which is barbed with minute serrations on its inner edge, while the outer edge of the second joint is finely dentate, with acute teeth.

The eyes are subcylindrical, with the coronal portion a little wider than the basis. No secondary differences between the sexes, except in the first abdominal somite.

*Habitat.*—The Challenger collection contains a single female specimen from Honolulu. The only other known specimen is a male from Matuku, Fiji Islands, described by White and also by Miers.

*Colour.*—White describes his dry specimen as "marbled," of a light yellowish-brown colour, varied with a darker colour. The Challenger specimen, preserved in alcohol, has a broad transverse light band across the carapace, while the rest of the dorsal surface is marked with brown pigment.

Length, $1\frac{12}{100}$ths inches.

7. *Protosquilla excavata* (Miers).

*Gonodactylus excavatus*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v. p. 123, pl. iii. figs. 11, 12.

*Diagnosis.*—Antero-lateral angles of carapace subacute, antero-lateral angles of rostrum acute, slender, shorter than elongated median spine. Fifth abdominal somite smooth. Sixth with six irregular longitudinal prominences, separated by deep interspaces, and confluent distally. Telson deeply excavated posteriorly, and with five prominent smooth longitudinal obtuse keels, the submedians longest and reaching to the postero-lateral lobe. First antennæ very long.

Length, $\frac{3}{4}$th inch.

*Locality.*—Miers describes this species from a single male specimen of unknown origin.

*Remarks.*—The published description does not state that the sixth abdominal somite is fused with the telson.

8. (?) *Protosquilla furcicaudata* (Miers).

*Gonodactylus furcicaudatus*, Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 124, pl. iii. figs. 13–16.

Although Miers does not state whether the sixth abdominal somite of this species is fused with the telson, it exhibits so many features of resemblance to the *Protosquillæ* that I place it here provisionally. It may be briefly described as follows. Eyes, antennæ, rostrum, carapace, exposed thoracic somites, and first five abdominal somites as

in *Protosquilla*. The sixth abdominal somite narrow, with six longitudinal prominences. Telson very short and transverse, with two slender spines projecting backwards from its posterior margin, with their bases in contact on the middle line, and their tips slightly divergent.

Comparison with the other *Protosquillæ* indicates that the two long spines of this species are the external marginal spines of the telson, which have become approximated on the middle line by the disappearance of almost the whole of the posterior border of the telson.

### Genus *Coronida*, n. gen.

The two following species *Gonodactylus bradyi* of A. Milne-Edwards, and *Gonodactylus trachurus*, Miers, resemble each other very closely and present many points of resemblance to the genus *Protosquilla*, but they are quite anomalous in other respects, since they present a most interesting and suggestive resemblance to *Squilla*, *Lysiosquilla* and *Gonodactylus*. Their features of resemblance to *Gonodactylus*, the enlargement of the base of the dactylus of the raptorial claw, the flat rectangular carapace, and the pointed rostrum, are at the same time features of resemblance to *Protosquilla*, and it seems probable that they are the living representatives of an ancestral type which was closely related on the one hand to *Protosquilla*, while on the other hand it was very similar to the common type of which *Lysiosquilla* and *Squilla* are the divergent descendants. As the most primitive species of the genus *Squilla* are often placed in a distinct genus *Chlorida*, while the lowest members of the genus *Lysiosquilla* are often placed in a distinct genus, *Coronis*, and as the features of resemblance to *Squilla* and *Lysiosquilla*, exhibited by the species now under discussion, point to a relationship with the lower rather than with the higher forms in these genera, I propose for them a generic name which shall express this fact, and the generic term *Coronida* is a compound of the first two syllables of *Coronis*, with the last two of *Chlorida*.

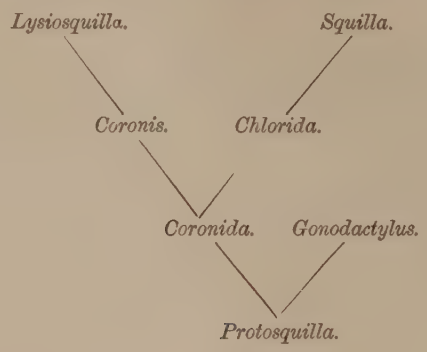
The two species of *Coronida* resemble *Protosquilla* in the minuteness of the antennary scales and uropods; in the fact that the anterior somites of the hind body are smooth, and conspicuously different from the sixth abdominal somite and telson, as well as in the presence of a median spine on the rostrum, and the enlargement of the base of the dactylus of the raptorial claw, and the shape of the carapace.

It is not stated that the sixth abdominal somite is fused with the telson, but the markings on the posterior end of the body are strikingly like those of *Protosquilla guerinii*, since Milne-Edwards describes this part of the body of *Coronida bradyi* in words which perfectly fit *Protosquilla guerinii*, as uniformly covered with numerous closely placed slender spines which are longest near the posterior margin, while Miers says that the posterior half of the fifth abdominal somite of *Coronida trachura* is

minutely spinulose on its posterior margin, a characteristic which is exactly duplicated in *Protosquilla guerinii*.

The two species differ from *Protosquilla* in the absence of antero-lateral spines on the rostrum, and the enlargement of the tips of the eyes, and from both *Protosquilla* and *Gonodactylus* in the presence of spines on the inner edge of the dactyle of the raptorial claw, and the depression of the hind body; resembling both *Squilla* and *Lysiosquilla* in these features.

The relationships of *Coronida* are therefore expressed in the accompanying diagram.




*Diagnosis.*—Hind body depressed, dactylus of raptorial claw dilated at base, and armed with spines on its inner edge. Rostrum ending in a small median spine. Antennary scales and uropods very small. Terminal segments of hind body and telson thickly set with small spines. Carapace flat and nearly rectangular.

*Coronida bradyi* (A. Milne-Edwards).

*Gonodactylus bradyi*, A. Milne-Edwards, Fonds de la Mer, vol. ix., 1869, p. 137, pl. xvii. fig. 11; Miers, E. J., On the Squillidæ, Ann. and Mag. Nat. Hist., ser. 5, vol. v., 1880, p. 117.
*Gonodactylus bradyi*, Miers, E. J., Crustacea from Mauritius, Proc. Zool. Soc. Lond., January 5, 1884, p. 16.

*Coronida trachura.*

*Gonodactylus trachurus*, Miers, E. J., Crustacea from Mauritius, Proc. Zool. Soc. Lond., January 5, 1884, p. 16.

*The Alima Larva and the Metamorphosis of Squilla.*

Although, as Claus has well shown in his classical monograph on the metamorphosis of the Stomatopoda,[1] the *Alima* larva is connected with the *Erichthus* larva by so many intermediate forms that it is difficult to draw an absolute line between them, it is nevertheless true that the *Alima* is more different from the *Erichthus* than any of the various modifications of the latter type are from each other, and in the description and discussion of the *Alima* larva which follows, I shall give my reasons for believing that all the *Alimæ* are the larvæ of adults which belong to the genus *Squilla*, and that all the species of this genus pass through an *Alima* stage, while all the other Stomatopods pass through their larval life as *Erichthi*. The *Alima* larva is undoubtedly a modified *Erichthus*, and some species deviate much more widely than others from the *Erichthus* type, but the group is on the whole sharply defined, and the rich supply of *Alima* larvæ brought home by the Challenger furnishes us with a very complete series of stages in the growth and development of several species of *Alima*, and thus shews that the history of all of them is essentially the same, and that they differ from all the other Stomatopods in the possession of numerous common characteristics which are also points of resemblance to the adult *Squilla*, a conclusion which receives added weight from the fact that Faxon has reared a young *Squilla empusa* from an *Alima* larva.

The complete history of the *Alima* which is furnished by the Challenger material is all the more valuable since Claus, who has given us, in his paper above quoted, a very complete history of the young stages of the *Erichthus* larva in all its more important modifications, had access to much more scanty material for studying the *Alima*. It is true that he gives figures and descriptions of many forms, but they are all well advanced and have the same number of somites and appendages as the adult Stomatopoda, and the fact that the Challenger collection contains consecutive series of several species of *Alima* from a very early stage up to the mature larva, with unmistakable characteristics of the genus *Squilla*, is therefore of great scientific interest.

The fully grown *Alima* is usually much larger than any of the *Erichthi*, and among the largest known pelagic larvæ. It leads an active swimming life, pursuing and capturing with the greatest rapacity the Copepods and other small Crustacea which form the chief part of its food. Its metamorphosis is slow, and the wide distribution of most of the species of *Squilla* is undoubtedly due to the fact that the larva is carried to distant localities by the winds and currents, but notwithstanding the great size, often 2 inches or more, which is attained by the fully-grown larva, the young *Alima*, even of the largest species, is very minute, and it is probable that all *Alimæ* hatch from the egg in the *Alima* form and that the *Erichthoidina* stage has been entirely dropped from their metamorphosis.

[1] Metamorphose der Squilliden, *Abhandl. d. k. Gesellsch. d. Wiss. Göttingen*, Bd. xvi. pp. 111–163, Tafs. i.–viii., 1871.

Although Claus decided that they are young *Lysiosquillæ* they show their relationship to the genus *Squilla* as distinguished from *Lysiosquilla* by the following characteristics, all of which are shared by all fully-grown *Alima* larvæ. The dactylus of the raptorial claw has on its inner edge a small number of marginal spines, usually about five or six; the hind body is wide and flat, and the postero-lateral angles of the abdominal somites end in acute spines. The outer edge of the proximal joint of the uropod is bordered by a small number of spines, usually less than eight, and the inner one of the two spines on the ventral process from the posterior edge of the basal joint of the uropod is longer than the outer, and it has a tooth or lobe on its outer edge; and the telson has six marginal spines with minute secondary spines between the submedians, and four or more larger secondary spines between the submedian and the second or intermediate, and usually a single one internal to the base of the third or lateral marginal spine. While it is true that all of these characteristics are not exhibited by every adult *Squilla*, there are no Stomatopods except those of this genus in which they are all united, and they are all of them present in most *Squillæ* and in all the *Alimæ*.

Joined to the fact that Faxon has reared a *Squilla* from an *Alima*, they indicate very clearly that the *Alimæ* are *Squilla* larvæ, and as we know of no other type of larva which can be referred to this genus, the present state of our knowledge indicates that all *Squillæ* have *Alima* larvæ. As it can be shown very conclusively that the *Alima* is an *Erichthus*, which has become accelerated in development and has dropped its *Erichthoidina* stage, and has become peculiarly adapted for a rapacious pelagic life, it is highly improbable that this change has taken place more than once, and as I shall give reasons for believing that it occurred very soon after the evolution of the genus *Squilla*, and that the larva of the most primitive of the true *Squillæ* is an *Erichthus*-like *Alima*, the conclusion that all the *Alimæ* are *Squilla* larvæ is warranted by the facts. The validity of these general conclusions can be better estimated after reading the descriptions of the larvæ which follow, but these descriptions will be the more intelligible if an outline of the generalizations to be drawn from them be kept in mind.

The *Alima* larva is characterised by the great elongation of the body, the possession of a flattened elongated carapace, with the posterior median dorsal spine absent or rudimentary, the elongated abdomen and usually several of the posterior thoracic somites exposed behind the posterior edge of the carapace, by the very great elongation of the region between the antennæ and the labrum, and by the fact that the eyes and eye stalks are usually exposed on the sides of the long slender rostrum. The carapace is narrow and its width is usually one-third or one-fourth of its length, although its total length makes a much smaller part of the total length of the body than it does in the *Erichthus* larva, as its increased length is more than overbalanced by the great elongation of the hind body. The older specimens of *Alima* are usually much larger than most of the *Erichthus* larvæ, and the inner one of the two spines which project backwards from the

ventral surface of the basal joint of the uropod is usually much longer than the outer, and is usually furnished with a tooth on its outer edge, and in the older specimens there are indications, underneath the cuticle, of spines on the inner edge of the dactylus of the raptorial claw. In his classical paper on the Metamorphosis of the Stomatopoda, Claus pointed out that there are so many features of resemblance between the *Alima* and the various forms of *Erichthus* that the larval nature of *Alima* cannot be doubted. Milne-Edwards and Dana had found it difficult to draw any line between the two genera; the first-named writer placing in the genus all Erichthidæ in which the ocular segment is exposed, while Dana includes in it those forms in which the distance from the anterior edge of the carapace to the mouth is greater than the distance from the mouth to the posterior edge. Claus shows that neither of these features serves to discriminate between *Alima* and *Erichthus* in every case, and he figures and describes a larval type which is intermediate between the two, having the elongated flattened carapace and the exposed eyes, but the mouth well forward, and the thoracic region well covered by the carapace. For this intermediate larval type he proposes the name *Alimerichthus*. Claus was not able to connect any one of his *Alimæ* with a specific adult, but he shows that they resemble the adults of the *Squilla* type very closely, and he correctly decides that they are the larvæ of this type, although he erroneously believes that they belong to the *Lysiosquilla* branch, rather than to the true *Squillæ*.[1] He says there can be no doubt that we must seek their adult representatives in the *Squilla*-group, and that the *Alima* larva, as distinguished from *Erichthus*, belongs exclusively to the genus *Lysiosquilla*, which is characterised, like the *Alima* larva, by the elongation and loose articulation of the abdomen. The lower members of the genus *Squilla* are loosely articulated, like the *Lysiosquillæ*, and the hind body is about as long in the one genus as it is in the other, and there is therefore no reason for believing that any of these larvæ are young *Lysiosquillæ*, although later researches have shown that he is correct in his surmise that they pertain to the *Squilla*-group.

In a paper which was published in 1879[2] I described a series of *Alima* larvæ, which were procured in abundance in the Chesapeake Bay, a locality where *Squilla empusa* is common, while no other Stomatopod is known to occur there, and I therefore advanced the opinion that this larva, a young stage of which is shown in figs. 4 and 5 of Pl. I., is a young *Squilla*. Three years before, Faxon reared from a similar but slightly more advanced larva, a young *Squilla*, which had the characteristics of the adult *Squilla empusa*, and although his results were not published until 1882[3] the proof that *Alima* is a young *Squilla* is due to him. It is of course possible that some species of *Lysiosquilla* may also pass through an *Alima* stage, but I shall show that, among

[1] Metamorphose der Squilliden, p. 154.

[2] On the larval stages of *Squilla empusa*.

[3] Selections from Embryological Monographs compiled by Alexander Agassiz, Walter Faxon, and E. L. Mark, I. Crustacea, Cambridge, 1882, *Bull. Mus. Comp. Zool.*, vol. ix. No. I., pl. viii. figs. 2, 3.

the lower *Lysiosquillæ*, in the subgenus *Coronis*, the larva is not an *Alima* but a *Squillerichthus*, and if it be true that *Squilla* and *Lysiosquilla* represent two divergent stems, and that their lower representatives are most closely related, it is not at all probable that any species of *Lysiosquilla* passes through an *Alima* stage, for if it were the case we should be forced to believe that the higher *Lysiosquillæ* have independently acquired the same secondary larval form as the higher *Squillæ*.

While Claus has given us a very complete history of the *Erichthus* larva his collections did not furnish a connected series of *Alima* larvæ, and although he points out the possibility that the very young larva which had been figured by Fritz Müller,[1] as well as a very similar one from Messina which he himself figures,[2] are young Alimæ, he was unable to obtain any of the intermediate stages, and my paper on the larval stages of *Squilla empusa* is the only one in which a tolerably complete series of *Alima* larvæ are figured. In this paper I showed that the distinctive characteristics of the larva are present at a very early stage of development, and that it is in all essential respects an *Alima* at a time when the last three thoracic somites are not yet marked out, and when there are no appendages between the large raptorial limbs of the second thoracic somite and the first abdominal appendages. I also pointed out the great probability that this larva leaves the egg as an *Alima* rather than as an *Erichthoidina* or an *Erichthus;* a probability which is strengthened by the fact that Fritz Müller has figured an egg containing a larva which is probably in this stage.

*Squilla* (*Alima*) *gracilis.*—The Challenger collection contains a number of larvæ which were collected in the tow-net at St. Vincent, and from these I have been able to select a series of *Alimæ,* which give a much more complete history of the growth and gradual modification of the larva than that which I obtained in 1879.

This series of larvæ, *Alima gracilis* of Milne-Edwards (*Alima angustata,* Dana) is shown in Pl. IV. figs. 4–6, Pl. V. fig. 3, Pl. VI. figs. 3–5, and Pl. VIII. figs. 4–6.

Its distinctive or specific characteristics are as follows:—The body is narrow and greatly elongated, the exposed hind body making about half the total length as measured from the tip of the long slender rostrum. The raptorial claw of the second thoracic appendage (Pl. VIII. fig. 5) is narrow and greatly elongated, and the dactylus is only about half as long as the second joint.

The telson is remarkably long and narrow, and in the older larvæ its length is three times its width. It has six large marginal spines (Pl. VI. fig. 3 and Pl. VIII. fig. 6) with minute spinules between the submedians, and also between the submedian and the intermediate. The lateral edge of the greatly elongated narrow flat carapace is armed with twelve or thirteen small spines and a larger spine projects from the side of the postero-lateral spine near its base. There is a small median dorsal spine on the posterior edge of the carapace, which exposes the last three thoracic somites, and is narrowed posteriorly

[1] *Archiv f. Naturgesch.*, Jahrg. xxviii. Taf. xiii. fig. 1. [2] Metamorphose der Squilliden, fig. 22*B*.

in the older larvæ. The inner spine of the prolongation from the basal joint of the uropod is much longer than the outer one, and it has a rounded lobe on its outer edge. The exopodite is armed on its outer edge with five or six marginal spines. The eyes are pear-shaped and the stalks very long. The mouth in old larvæ is under the posterior fourth of the carapace; the postero-lateral angles of all the abdominal somites are prolonged into acute spines, and the dactylus of the raptorial claw shows traces of five marginal spines.

*Alima gracilis* is one of the best known and widely distributed Stomatopod larvæ, and any naturalist who has the good fortune to be becalmed in tropical waters should be able to determine the adult to which it belongs without difficulty, as the older Stomatopod larvæ thrive and moult in small aquaria. The very close resemblance between it and the *Alima* from which Faxon reared a young *Squilla empusa* shows beyond doubt that the adult is one of the highly specialized carinate *Squillæ*, and its wide distribution indicates that the adult also is very widely distributed. The most striking difference between it and other *Alimæ* is the great elongation which takes place in the telson during the latest stages. The late appearance of this character indicates that it is shared by the adult, and as there is no known species with a long narrow telson, and as it is hardly possible that an animal which must be one of the largest and most widely distributed of the Stomatopods, should have escaped discovery if it were littoral in its habits, it is probable that *Alima gracilis* is the larva of an unknown, deep-water *Squilla*, with an elongated telson and a long raptorial claw.

The smallest larva in the series from St. Vincent (No. 1) measures $5\frac{26}{100}$ mm. from the tip of the rostrum to the middle line of the telson; the second (No. 2, Pl. IV. fig. 4) measures $6\frac{91}{100}$ mm., the third (No. 3, Pl. V. fig. 3) $9\frac{18}{100}$ mm., the fourth (No. 4, Pl. IV. fig. 5) $11\frac{54}{100}$ mm., the fifth (No. 5, Pl. IV. fig. 6) $17\frac{38}{100}$ mm., and the sixth (No. 6, Pl. VI. fig. 3) $42\frac{83}{100}$, or a little less than Claus' larva,[1] which is a little less than 52 mm. long. This large larva is well known and widely distributed, and the Challenger collection contains numerous specimens from St. Vincent, the west coast of Africa, the Central Pacific, and the vicinity of Cape York.

The youngest larva (No. 1) of the table was not figured as there is no difference, except in size, between it and No. 2, which is shown in Pl. IV. fig. 4. In this larva all the somites of the hind body, except the fifth and sixth abdominal, are distinct, and the outline of the fifth is indicated. The appendages of the sixth abdominal are entirely absent, those of the fifth are rudimentary bilobed pouches, while the first four are well developed and functional, with a very long basal joint, and an appendix interna on the endopodite.

There are no traces of appendages on the last six thoracic somites, and the third,

[1] Metamorphose der Squilliden, pl. viii. fig. 35.

| *Alima gracilis.* Measurements. | In millimetres. | | | | | | In thousandths of total length. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. |
| Measurements along middle line:— | | | | | | | | | | | | |
| Total length from tip of rostrum to tip of telson, | 5·3 | 6·9 | 9·1 | 11·54 | 17·37 | 42·83 | ... | ... | ... | ... | ... | ... |
| Total length of carapace including rostrum, | 2·8 | 3·8 | 5·04 | 5·82 | 8·34 | 20·17 | 532 | 544 | 541 | 505 | 492 | 484 |
| Total length of rostrum, | ·96 | 1·3 | 1·6 | 1·84 | 1·92 | 3·32 | 182 | 187 | 174 | 160 | 110 | 80 |
| From tip of rostrum to anterior edge of ocular somite, | ·96 | 1·3 | 1·6 | 1·84 | 1·92 | 3·32 | 182 | 187 | 174 | 160 | 110 | 80 |
| From anterior edge of ocular somite to line joining bases of antero-lateral spines, | ·32 | ·4 | ·56 | ·80 | ·70 | 1·66 | 61 | 58 | 61 | 69 | 41 | 40 |
| From line joining bases of antero-lateral spines to tip of labrum, | ·48 | ·7 | 1·2 | 1·34 | 3·68 | 11·10 | 91 | 104 | 131 | 117 | 212 | 266 |
| From tip of labrum to anterior edge of third thoracic somite, | ·64 | ·8 | ·9 | 1·20 | 1·12 | 2·07 | 122 | 116 | 96 | 104 | 64 | 50 |
| Third thoracic somite, | ·05 | ·08 | ·08 | ·10 | ·13 | ·41 | 9 | 12 | 8 | 8 | 7 | 10 |
| Fourth thoracic somite, | ·10 | ·11 | ·11 | ·13 | ·13 | 1·10 | 18 | 16 | 12 | 11 | 7 | 26 |
| Fifth thoracic somite, | ·11 | ·16 | ·19 | ·26 | ·38 | 1·41 | 21 | 23 | 21 | 22 | 22 | 34 |
| Sixth thoracic somite, | ·14 | ·19 | ·22 | ·37 | ·54 | 1·41 | 27 | 28 | 24 | 32 | 31 | 34 |
| Seventh thoracic somite, | ·19 | ·22 | ·27 | ·40 | ·58 | 1·83 | 36 | 32 | 30 | 35 | 33 | 44 |
| Eighth thoracic somite, | ·19 | ·29 | ·35 | ·40 | ·64 | ... | 36 | 42 | 38 | 35 | 37 | ... |
| From anterior edge of fourth thoracic to anterior edge of first abdominal somite, | ·78 | 1·06 | 1·23 | 1·65 | 2·40 | 6·16 | 149 | 153 | 134 | 143 | 138 | 148 |
| First abdominal somite, | ·29 | ·35 | ·51 | ·64 | ·90 | 2·24 | 55 | 51 | 56 | 55 | 52 | 54 |
| Second abdominal somite, | ·30 | ·37 | ·51 | ·64 | ·96 | 2·24 | 58 | 53 | 56 | 55 | 55 | 54 |
| Third abdominal somite, | ·26 | ·37 | ·48 | ·56 | ·96 | 2·07 | 58 | 53 | 52 | 49 | 55 | 50 |
| Fourth abdominal somite, | ·21 | ·21 | ·37 | ·54 | ·90 | 2·16 | 39–49 | 30 | 40 | 47 | 52 | 52 |
| Fifth abdominal somite, | ·13 | ·14 | ·19 | ·45 | ·64 | 1·90 | 24 | 21 | 21 | 39 | 37 | 46 |
| Sixth abdominal somite, | ... | ... | ... | ·22 | ... | ·83 | ... | ... | ... | 19 | ... | 20 |
| Telson on middle line, | ·90 | 1·20 | 1·65 | 1·65 | 3·20 | 7·05 | 170 | 174 | 178 | 143 | 184 | 196 |
| Total length of abdomen and telson, | 2·08 | 2·64 | 3·71 | 4·70 | 7·55 | 18·51 | 395 | 382 | 408 | 408 | 435 | 444 |
| Total length of body on middle line, | 5·26 | 6·91 | 9·18 | 11·54 | 17·38 | 42·83 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Measurements of carapace:— | | | | | | | | | | | | |
| Total length on middle line including rostrum, | 2·8 | 3·76 | 5·04 | 5·82 | 8·34 | 20·17 | 540 | 548 | 541 | 505 | 492 | 484 |
| Length of rostrum, | ·96 | 1·30 | 1·6 | 1·84 | 1·92 | 3·32 | 182 | 187 | 174 | 160 | 110 | 80 |
| Length of antero-lateral spines, | ·40 | ·53 | ·67 | ·72 | ·84 | 1·16 | 076 | 76 | 73 | 62 | 48 | 28 |
| Length of postero-lateral spines, | 0·72 | ·93 | 1·44 | 1·84 | 1·76 | 2·49 | 287 | 134 | 157 | 160 | 101 | 55 |
| Width at bases of antero-lateral spines, | ·96 | 1·34 | 1·36 | 1·33 | 1·76 | 3·65 | 182 | 194 | 148 | 115 | 101 | 88 |
| Width at bases of postero-lateral spines, | 1·52 | 2·08 | 2·88 | 2·88 | 3·68 | 6·64 | 289 | 300 | 314 | 250 | 212 | 158 |
| Width of seventh thoracic somite, | ... | ·32 | ·51 | ·51 | ·48 | 1·00 | ... | 46 | 55 | 44 | 28 | 24 |
| Width of eighth thoracic somite, | ·27 | ·32 | ·51 | ·56 | ·51 | 1·16 | 52 | 46 | 55 | 48 | 29 | 28 |
| Width of second abdominal somite, | ·40 | ·43 | ·51 | ·76 | ·64 | 1·66 | 76 | 61 | 56 | 67 | 37 | 40 |
| Width of fifth abdominal somite, | ·32 | 0·43 | ·40 | ·75 | ·64 | 1·10 | 60 | 61 | 44 | 65 | 37 | 46 |
| Greatest width of telson, | ·80 | 1·02 | 1·28 | 1·60 | 1·92 | 3·57 | 152 | 148 | 139 | 139 | 110 | 86 |
| Distance between submedian spines of telson, | ·45 | ·53 | ·51 | ·77 | ·54 | 1·00 | 85 | 76 | 56 | 67 | 31 | 24 |
| First pleopod, basal portion, | ·40 | ... | ·51 | ·69 | ·74 | 1·00 | 76 | ... | 56 | 60 | 43 | 24 |
| First pleopod, exopodite, | ·25 | ... | ·51 | ·51 | ·70 | 1·49 | 46 | ... | 56 | 44 | 40 | 36 |
| Second maxillipod, basal joint, | ·27 | ·32 | ·40 | ·56 | ·38 | 1·00 | 52 | 46 | 44 | 49 | 22 | 24 |
| Second maxillipod, second joint, | ·67 | ·83 | 1·12 | 1·28 | 1·92 | 4·98 | 128 | 116 | 122 | 111 | 110 | 119 |
| Second maxillipod, third joint, | ·83 | 1·09 | 1·44 | 1·60 | 2·08 | 5·23 | 158 | 144 | 157 | 139 | 120 | 125 |
| Second maxillipod, fourth joint, | ·25 | ·24 | ·32 | ·32 | ·38 | ·66 | 46 | 35 | 35 | 28 | 22 | 16 |
| Second maxillipod, sixth joint, | 1·28 | 1·52 | 2·24 | 2·32 | 3·20 | 5·40 | 243 | 220 | 244 | 201 | 184 | 129 |
| Second maxillipod, dactyle, | ·83 | ·93 | 1·36 | 1·20 | 1·92 | 3·65 | 158 | 134 | 148 | 104 | 110 | 88 |
| First antenna, first joint, | ·16 | ·24 | ·32 | ·43 | ·54 | 1·41 | 30 | 35 | 35 | 37 | 31 | 34 |
| First antenna, second joint, | ·11 | ·18 | ·22 | ·28 | ·32 | ·91 | 21 | 25 | 14 | 25 | 18 | 22 |
| First antenna, third joint, | ·21 | ·24 | ·29 | ·32 | ·38 | 1·00 | 52 | 35 | 31 | 28 | 22 | 24 |
| First antenna, flagellum, | ·40 | ·48 | ·70 | ·96 | 1·12 | 1·41 | 76 | 69 | 77 | 83 | 64 | 39 |
| Eye stalk, | ·32 | ·56 | ·64 | ·72 | ·96 | 1·66 | 61 | 81 | 62 | 62 | 55 | 40 |
| Eye, | ·48 | ·72 | ·67 | ·96 | 1·12 | 1·33 | 91 | 104 | 65 | 83 | 64 | 32 |

fourth, and fifth are short, and wider than long, while the sixth, seventh, and eighth are elongated, and about as long as they are wide. The second antenna has a two-jointed

shaft, and a broad oval exopodite or scale, but no flagellum, and the three-jointed shaft of the first antenna carries two short unjointed terminal pouches. The eye stalks are very long, slender, and transverse, and the eyes broad at the rounded conical end. The long slender rostrum is about half ($\frac{1}{3}\frac{8}{5}$) as long as the carapace, and the distance from its base to its tip is about equal to the distance from its base to the tip of the labrum. The carapace widens posteriorly, and its width between the bases of the antero-lateral spines is more than half ($\frac{1}{2}\frac{8}{9}$) of its width between the bases of the postero-lateral spines. Its lateral edges are straight, and would if prolonged meet at the tip of the rostrum. The carapace and rostrum make up considerably more than half $\frac{5}{1}\frac{4}{0}\frac{4}{0}$ of the total length, and the posterior edge of the carapace, which is nearly transverse, lies on the posterior edge of the sixth thoracic somite, while the tips of the divergent postero-lateral spines are in the plane of the anterior end of the second abdominal somite. The telson is oval and its length is a little ($\frac{1}{1}\frac{7}{5}$) greater than its width. The lateral marginal spines are about midway between the anterior and posterior ends of the telson; the space between them and the intermediate is a little shorter than the space between the intermediate and the submedian. There are seven small teeth between the intermediate and the submedian, and the distance between the submedians is $\frac{8}{1}\frac{5}{0}\frac{5}{0}\frac{5}{0}$ of the total length. There are only three small spines on the outer edge of the carapace at this stage, and they are all behind the middle.

Larva No. 3, $9\frac{1}{1}\frac{8}{0}\frac{8}{0}$ mm. long, is shown in Pl. V. fig. 3. The fifth abdominal somite is now distinct, but much shorter than those in front of it, and its appendages are perfectly formed but small and without the appendix interna. The thoracic somites and appendages are like those of No. 2. The antennæ are like those of No 2, except that the two flagella of the first antenna are divided each into three joints. The rounded conical end of the eye is broader than in the previous stage, and there have been important changes in the relative length of the carapace and hind body. The rostrum is less than half ($\frac{1}{3}\frac{7}{7}$) as long as the carapace, and the distance from its base to its tip is only $\frac{1}{1}\frac{8}{9}$ of the distance from its base to the tip of the labrum. The carapace still has the same general shape, and its lateral edges are straight, with three spines on the posterior half, but its width between the bases of the postero-lateral spines is relatively less, and the width between the bases of antero-laterals is to that between the postero-laterals as 15 to 31, or about 1 to 2. In most other respects this larva is very similar to No. 2.

Larva No. 4 is shown in Pl. IV. fig. 5. It may possibly belong to a different species, as it has only one spine on the lateral edge of the carapace, but if distinct it must belong to some very closely related species, as there are no essential differences in the measurements. The third, fourth, and fifth thoracic somites are shortened and crowded together, and their appendages have appeared as bud-like outgrowths, while the appendages of the sixth, seventh, and eighth thoracic somites are also represented by similar but much smaller buds. The sixth abdominal somite has not yet been separated

from the telson, although its appendage is represented by a minute bilobed bud. This larva therefore has all the appendages of the adult, either functional or represented by buds, and all the somites of the hind body except the sixth abdominal. The outer ramus of the flagellum of the first antenna is now bilobed, and the flagellum of the second antenna is represented by a bud, and the ocular somite is distinct and movable. The rostrum is a little less than half as long as the carapace, and the labrum is still farther back. The width of the carapace between the bases of the antero-lateral spines is $\frac{11}{25}$ of its width between the bases of the postero-lateral spines, and the carapace with the rostrum makes up almost exactly half of the total length ($\frac{505}{1000}$). In other respects this larva closely resembles No. 3.

Larva No. 5, $17\frac{37}{100}$ mm. long, is shown in Pl. IV. fig. 6. The sixth abdominal somite is still absent, and its appendages and those of the three last thoracic somites rudimentary, although those of the third, fourth, and fifth thoracic somites have assumed nearly their final form, and the first antenna has its three-jointed flagella.

Although actually longer than that of No. 4, the rostrum is now relatively much shorter, and only about one-fourth ($\frac{1}{3\cdot9}$) as long as the carapace, and the distance from its base to its tip is less than one-half ($\frac{11}{25}$) of the distance from its base to the tip of the labrum.

The carapace is still shorter, as compared with the hind body, and with the rostrum, it now makes up less than half ($\frac{492}{1000}$) of the total length, although its lateral edges are still straight, and its triangular shape is still retained. The greatest change is in the length of the telson, which is now nearly twice as long as wide.

Larva No. 6, $42\frac{8}{10}$ mm. long, is shown in Pl. VI. fig. 3. It has all the somites and appendages of the adult, although the sixth pair of abdominal appendages are rudimentary. The carapace is still more elongated, and although the rostrum is actually longer than it was in stage 5, it is much shorter both as compared with the total length of the body of which it now makes $\frac{8}{100}$, and also as compared with the carapace, which is more than five times ($\frac{404}{80}$) as long as the rostrum. One of the most prominent characteristics of the fully grown *Alima gracilis* is the great distance of the mouth from the anterior end of the body, and in larva No. 6 the length of the rostrum is little more than one-fourth ($\frac{8}{30}$) the distance from its base to the tip of the labrum. The carapace including the rostrum makes a slightly smaller portion of the total length ($\frac{484}{1000}$) than at stage 5, and its lateral edges are no longer straight but are incurved near their posterior ends, so that there is no increase in width in the posterior third of the carapace. In the still older larva figured by Claus, this peculiarity is still more marked, and the broadest part of the carapace is some distance in front of its posterior margin; this is more emarginated in stage 6 than it is in younger larvæ, and it crosses the middle of the sixth thoracic somite. The telson is still more narrow and elongated, and the submedian spines (Pl. VI. fig. 3), which have become more and more closely approxi-

mated to each other at each successive moult, are now separated by a space equal to only $\frac{24}{1000}$ or less than $\frac{1}{40}$ of the total length, while in stage 1 the distance between them is $\frac{85}{1000}$ of the total length. As shown in Pl. VIII. fig. 6, there are fourteen short acute spines between the submedians, with still smaller spines between them, and there are fifteen small acute dentations between each submedian and the intermediate of the same side, which is about equal in length to the submedian.

The uropod of a specimen of the same size, which was captured at the surface by the Challenger expedition, between Api and Cape York, is shown in ventral view in Pl. VIII. fig. 4. The exopodite is now divided into a paddle and a second joint, and the latter has five spines on its outer margin. The ventral prolongation from the basal joint ends in a short outer spine and a much longer inner one, which has a rounded lobe on its outer margin, near the base.

From the table of measurements given above the following measurements may be selected as showing the character of the changes through which the larva passes during its growth. They are all in thousandths of the total length from the tip of the rostrum.

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. |
|---|---|---|---|---|---|---|
| Rostrum, . . . . . | 187 | 182 | 174 | 160 | 111 | 80 |
| Carapace, exclusive of rostrum, . . . . . | 357 | 350 | 367 | 345 | 381 | 404 |
| Width of carapace between bases of antero-lateral spines, . | 194 | 182 | 148 | 115 | 101 | 88 |
| Width of carapace between bases of postero-lateral spines, . | 301 | 289 | 314 | 249 | 212 | 158 |
| Length of abdomen including telson, . . . | 382 | 395 | 403 | 408 | 435 | 444 |
| Distance between submedian spines of telson, . . | 76 | 85 | 56 | 67 | 31 | 24 |

While *Alima gracilis* differs from ordinary *Alimæ* in many respects, especially the great elongation of the body, the shortness of the carapace, and the elongation of the telson, Claus has figured a series of *Alimæ* which shows that the shorter and wider species are connected with the elongated ones by so many intermediate forms that there can be no doubt that the adults which they represent are all closely related. The Challenger collection also contains great numbers of these intermediate forms, and I give in Pl. VII. fig. 7 and Pl. VIII. fig. 7 figures of the telson and the raptorial claw of one of them, which resembles *Alima gracilis* in the shape of its carpus, while its telson and the general outline of the body are so much like Faxon's larva as to indicate that it is the young of a species of *Squilla* very closely related to *Squilla nepa*. A number of specimens of this larva were collected by the Challenger on April 13, 1876, near Sierra Leone. The carapace makes about half the total length of the body, and it exposes the posterior end of the sixth thoracic somite, while the tips of its postero-lateral spines, each of which has a small secondary spine about midway between the base and the tip, extend backwards to the plane of the suture between the first and

the second abdominal somites. The lateral edge of the carapace has a few, five or six, marginal spines, and a well marked dorsal spine. The postero-lateral angles of the abdominal somites end in acute spines, and the inner and longer of the two basal spines of the uropod has a rounded lobe on its outer edge close to its base. The carpal joint of the raptorial claw is as much elongated as it is in *Alima gracilis*, although the telson is no longer than its width. As the adult form is certainly a *Squilla*, closely related to *Squilla nepa* and *Squilla mantis*, it does not seem necessary to give the larva a provisional name.

*Squilla* (*Alima*), *empusa*.—In order to render the series of *Alima* larvæ more complete, I give two figures, a ventral and a side view (Pl. I. figs. 4, 5), of a larva which is smaller and probably one moult younger than any of those in the Challenger collection.

The drawings were made from the living larva, which is probably the larva of *Squilla empusa*, and the same as the one which is shown in Faxon's pl. vi. fig. 17. It is 3·216 mm. long and the last six thoracic somites increase uniformly in length from in front backwards, and have no traces of appendages; the sixth abdominal somite is absent, and the fifth very short and without appendages. The telson is longer than wide, narrowed anteriorly and posteriorly, and the four spines between the submedian and the intermediate are nearly as large as the latter. The rostrum is short, and not quite as long as the slightly divergent postero-lateral spines of the carapace, which is oval in outline and nearly as wide in front as behind. It crosses the posterior end of the seventh thoracic somite in the middle line, and the tips of the postero-lateral spines are about opposite the middle of the third abdominal somite. The tip of the labrum is close to the anterior end of the carapace, and the eye-stalks are short, less than half as long as the eyes.

*Alima bidens*.—Claus has figured and described,[1] under the provisional name *Alima bidens*, an *Alima* larva which is of especial interest, as many of its organs, especially the gills and the dactyles of the raptorial claws, undergo much more complete development during the larval life than is usually the case, and it therefore presents more data than the ordinary larvæ for establishing an identity with some one of the genera of adult Stomatopods.

Although Claus regarded it as the larva of some species of *Lysiosquilla*, I shall show that *Alima bidens* must be referred to the genus *Squilla*, and there is, so far as I am aware, no other Stomatopod larva which exhibit clearer evidences of relationship to a definite adult genus.

It is of course desirable that some one who has the opportunity should actually rear it, and determine in this way the specific adult of which it is the larva, but in the absence of this decisive proof the evidence that it is a *Squilla* could hardly be stronger than it now is.

Claus obtained only a single larva 26 mm. long from the Indian Ocean, and as this

[1] Metamorphose der Squilliden.

| *Squilla* (*Alima*), *empusa*. Measurements. | In inches and decimals. | In thousandths of total length. |
|---|---|---|
| Measurements on middle line:— | | |
| Rostrum, | ·496 | 153 |
| From base of rostrum to tip of labrum, | ·320 | 101 |
| From tip of labrum to anterior edge of third thoracic somite, | ·512 | 158 |
| Third thoracic somite, | ·064 | 20 |
| Fourth thoracic somite, | ·064 | 20 |
| Fifth thoracic somite, | ·064 | 20 |
| Sixth thoracic somite, | ·080 | 25 |
| Seventh thoracic somite, | ·096 | 30 |
| Eighth thoracic somite, | ·112 | 35 |
| First abdominal somite, | ·160 | 50 |
| Second abdominal somite, | ·160 | 50 |
| Third abdominal somite, | ·160 | 50 |
| Fourth abdominal somite, | ·160 | 50 |
| Fifth abdominal somite, | ·048 | 15 |
| Telson, | ·720 | 223 |
| Total length on middle line, | 3·216 | 1000 |
| Length of carapace on middle line, | 1·648 | 411 |
| Width of carapace between bases of antero-lateral spines, | ·704 | 218 |
| Width of carapace between bases of postero-lateral spines, | ·736 | 228 |
| Width of telson between submedian spines, | ·320 | 99 |
| Width of telson (greatest), | ·448 | 139 |
| Length of abdomen including telson, | 1·408 | 438 |

specimen, which is shown in Claus's figure 34, has on the dactylus of the raptorial claw two marginal spines besides the terminal one, he derives the provisional specific name from this characteristic.

The Challenger collections contain two specimens of the same larval type; one from the Cape of Good Hope (Pl. IX. figs. 1 and 2), a little older than Claus's larva, and with three spines on the dactylus besides the terminal one, and 25·39 mm. long; and another from the Gulf of Penas, younger than Claus's larva, with only one spine, and 17·57 mm. long. The two specimens, which undoubtedly belong to a single species, differ very slightly from Claus's larva, which may possibly be the young of a distinct species, although the differences are so very slight that it seems best to retain Claus's specific name *Alima bidens* for them all.

*Alima bidens* is characterised as follows:—The very short and narrow carapace, which has no median dorsal spine, makes with the dorsal rostrum only $\frac{2}{5}$ of the total length, and its deeply emarginated posterior edge exposes the four posterior thoracic somites. The long tip of the slender rostrum is in front of the end of the shaft of the first antenna, and the length of the rostrum is a little more than half the length of the carapace, measured on the middle line from its base. The antero-lateral spines of the carapace are unusually long and divergent; the tips of the long postero-laterals are opposite

the middle of the first abdominal somite, and they have two or three small secondary spines on their inner edge, while the lateral margin of the carapace, immediately anterior to the base of the postero-lateral spine, has two well-marked lateral spines on each side.

The hind body is greatly elongated, making about $\frac{10}{17}$ or a little less than $\frac{3}{5}$ of the total length from the tip of the rostrum. In older larvæ the abdomen is depressed, and its width is equal to $\frac{1}{5}$ of the total length. The inner spine of the basal prolongation of the uropod is much longer than the outer, and it has a small tooth on its outer margin, about half way between the base and the tip. The telson is slightly elongated, with six marginal spines, and with secondary dentations between the submedians, and also between the submedian and the intermediate. The eye-stalks are nearly as long as the eyes, and the mouth is a little behind the middle point of the carapace, as measured from the tip of the rostrum.

In Claus's larva there are three secondary spines on the inner edge of the postero-lateral spine of the carapace, while there are only two such spines in each of the Challenger specimens.

In the smallest of the Challenger specimens the dactylus of the raptorial claw has a single marginal spine besides the terminal one, the uropods are very small, and the gills are represented by simple pouches on the exopodites of the first five pairs of abdominal appendages. The carapace, with the rostrum, makes $\frac{412}{1000}$, the hind body $\frac{588}{1000}$, and the width of the abdomen $\frac{206}{1000}$ of the total length.

In the older specimen (Pl. IX. fig. 1) the dactylus is armed with three well-developed marginal spines besides the terminal one, the uropods are nearly half as long as the telson, with the exopodite divided into a broad rounded paddle and a second joint which is fringed with six marginal spines, and the prolongation from the posterior edge of the ventral surface of the basal joint is as long as the exopodite, and ends in a short acute curved outer spine and a much longer inner spine, which has a tooth on its outer margin about half way between the base and the tip.

The carapace has a well-marked median carina; the postero-lateral angles of the broad flat abdominal somites all end in acute spines, and there are two submedian carinæ, ending posteriorly in spines, on the dorsal surface of the sixth abdominal. The telson has a median longitudinal carina, and is slightly longer than wide. Its lateral edges, from the anterior edge to the tips of the intermediate marginal spines, are nearly parallel; between the intermediates and the submedians they are inclined inwards and backwards at an angle of 45° with the long axis of the body, while between the submedians they are inclined inwards and forwards. The lateral marginal spine (fig. 2) is nearer to the intermediate than to the anterior edge, and it has a single minute spine internal to its base. The intermediate is longer than the lateral or the submedian, and there are twelve or thirteen small spines between it and the submedian, and there are about twenty very minute spines between the submedian and the middle line.

In this larva, which is 1 inch long, the carapace makes, with the rostrum, $\frac{400}{1000}$, the exposed hind body $\frac{600}{1000}$, and the telson $\frac{200}{1000}$ of the total length.

Even if the close resemblance between this larva and the one from which Faxon reared a young *Squilla empusa* did not indicate that *Alima bidens* is also a *Squilla*, this could be inferred with great certainty from the examination of the larva itself, since it resembles the adults of this genus in the presence and in the small number of spines on the inner edge of the dactylus of the raptorial claw, in the depression and width of the hind body, in the presence of a median-dorsal carina on the carapace and on the telson, in the presence of acute spines on the postero-lateral angles of the abdominal somites, in the presence and in the small number of marginal spines on the outer edge of the proximal joint of the exopodite of the uropod, in the relative length of the two spines of its ventral process, in the presence of a secondary tooth on the outer edge of the inner and longer spine, in the relative positions of the marginal spines of the telson, in the presence of a single minute dentation inside the base of the lateral, and a number of dentations (more than three) between the intermediate and the submedian. While it is true that there are some adult *Squillæ* which do not shew all of these characteristics, and while no one of them is in itself perfectly diagnostic, it is also true that there are no Stomatopods in which they are all united except members of the genus *Squilla*, and we may therefore decide, with all the certainty which is possible in absence of direct proof, that *Alima bidens* is the larva of one or perhaps of two species of the higher carinate *Squillæ*. The presence of three secondary spines on the inner edge of the postero-lateral spine of the carapace of Claus's larva, and of only two in our specimen, possibly corresponds to a specific difference between the adults.

*Alima macrophthalma*.—The Challenger collection contains a number of specimens of an *Alima* larva of a type which is quite different from that of which *Alima gracilis* is an example, and I have selected from a surface gathering, made near Cape Howe, the series which is shown in Pl. VII. figs. 1–6; Pl. VIII. figs. 1–3.

It is possible that these are not all of one species, but the differences between them are so slight that, if not the same, they must at least belong to adults which are very closely related, and as I am not able to identify the larva with any of the published descriptions, I propose for it the provisional name *Alima macrophthalma*, on account of the great size of the eyes as compared with the very small eye stalks.

The youngest larva which I have found, No. 1, is essentially like No. 2. The telson is shown in Pl. VII. fig. 2; No. 2, which is shown in Pl. VII. fig. 1, is $4\frac{9}{10}$ mm. long; No. 3, shown in fig. 4, is $6\frac{4}{10}$ mm. long; No. 4, shown in fig. 5, is $8\frac{4}{10}$ mm. long; No. 5, shown in Pl. VIII. fig. 1, is $8\frac{75}{100}$ mm. long; No. 6, shown in fig. 2, is $11\frac{11}{100}$ mm. long, and No. 7, shown in Pl. VIII. fig. 3, is 19 mm. long.

The most prominent diagnostic characteristics of *Alima macrophthalma* are as follows. The eye-stalks are very short, and the eyes large with very broad tips; the

labrum is near the middle of the carapace, which is narrow and elongated, exposing the fifth, sixth, seventh and eighth thoracic somites, and very much shorter than the elongated hind body. The carapace has a median dorsal spine, about as long as the antero-lateral spine, on its posterior edge, and there is a single acute straight spine on the lateral margin of the carapace, on each side, immediately anterior to the postero-lateral, the tip of which reaches nearly to the line of the anterior edge of the first abdominal somite.

In the younger larvæ the posterior edge of the carapace is transverse, and the telson is narrowed anteriorly, while in older larvæ the carapace is deeply emarginated, and the lateral edges of the telson nearly parallel. In the oldest larva the inner spine of the uropod is longer than the outer, with a rounded lobe on its outer edge, the abdomen is depressed, about as wide as the carapace between the bases of the antero-lateral spines, and the postero-lateral angles of all the abdominal somites end in acute spines.

This series, together with the *gracilis* series, gives a very complete picture of the changes which the *Alima* larva undergoes during its larval life. In the youngest stage which was observed (Pl. VII. figs. 1 and 2) the shaft of the first antennæ has only two joints, and the appendage ends in only two rami. There is no flagellum on the second antenna, and no appendages between the raptorial second thoracic limbs and the first pair of abdominal appendages. All the four thoracic somites are wider than long, and the third, fourth, and fifth are equal in length, and more than half as wide as those which follow. The abdomen is narrow, very slightly wider than the thorax, with five distinct somites, the last of which is short without appendages, while the appendages of the fourth are rudimentary. Those of the third, second, and first are functional, long and slender, with a long appendix interna. The tip of the labrum, which has no spine, is slightly anterior to the middle line, and the greatest width of the carapace is slightly less than its length. It narrows a little posteriorly, and its width between the bases of the postero-lateral spines is very slightly greater than its width between the bases of the antero-laterals.

The width of the telson at its anterior end is about half the greatest width (see figs. 1 and 2) and it is also slightly narrowed posteriorly. The posterior border, between the submedian spines (fig. 2) is straight and transverse, with about eighteen small spines.

The intermediate spines are near the middle of the telson, separated by a slight interval from the laterals, and by a much longer interval from the postero-median, with some intervening dentations which are about as large as the primary spines.

At the next stage (No. 3, fig. 4) the appendages are as before, except that the fourth abdominal appendages are larger, and the fifth pair are now present as rudiments. The position of the labrum and the shape of the carapace is essentially as in stage 2, and the telson is also nearly the same except that its posterior border is slightly emarginated. At the next stage (No. 4, fig. 5) the flagellum of the second antenna, the appendages of the third thoracic somite, and those of the sixth abdominal somite, are all represented by minute buds, and the third thoracic somite has become shorter than

the fourth and fifth. The outline of the carapace is about as before, except that it is now deeply emarginated on the middle line. The posterior border of the telson is slightly emarginated; the submedian spines have approached each other, and the intermediates, which are now much larger than the seven secondary dentations, have moved backwards, as have also the laterals.

In the next stage (No. 5, Pl. VIII. fig. 1) more important changes have taken place. The third, fourth, and fifth thoracic appendages are represented by buds, and their somites have become reduced in length, so that the sixth is as long as all three of them. The abdomen is now much wider than the thorax, and its somites all end posteriorly in acute spines. The labrum is a little further back, and the anterior end of the carapace narrower than at stage 4, but the telson is essentially like that of stage 4, although it is a little more emarginated in the middle line. In stage 6 (fig. 2) the labrum is still further back, the flagellum of the second antenna and the appendages of the third, fourth, and fifth thoracic somites are elongated, and the latter are obscurely divided into joints; the appendages of the sixth, seventh, and eighth thoracic somites are represented by buds, the abdomen is wider and more depressed, and the appendages of the sixth somite are parallel but well developed. The space between the lateral and the intermediate spines of the telson is now equal to the space between the intermediate and the submedian, and the posterior border is deeply notched on the middle line. In the oldest larva in this series (No. 7, fig. 3) the appendages all have essentially their adult forms, and the more important changes are the lengthening of the hind body, the flattening and widening of the abdomen, and especially the widening of the sixth abdominal somite and the anterior end of the telson. This is now nearly rectangular, and deeply notched on the middle line; the submedian spines are more approximated, and the intermediates further back.

Although the collection contains no specimens which serve to connect this larva with a specific adult, its close resemblance to the more typical *Alimæ*, especially *Alima bidens*, gives every reason for believing that it is the young of one of the higher multicarinate species of the genus *Squilla*.

The specimens are all from the coast of Australia, and all these which were drawn were from Cape Howe and its vicinity.

*Alimerichthus*.—Inasmuch as the *Erichthus* type of Stomatopod larvæ presents a very much greater diversity of forms than the *Alima* type, and as it is preceded by a *Erichthoidina* stage which is absent in the *Alima* larvæ, there can be no doubt that the latter type is a secondary modification of the *Erichthus* type, and that the greatly elongated *Alimæ* like *Alima gracilis* (Pl. VI. fig. 3) are more divergent from the primitive larva than the shorter and broader forms like *Alima macrophthalma* (Pl. VIII. fig. 3). Although Milne-Edwards and Dana have attempted to show that the two types are sharply separated, Claus has pointed out that among the *Alimæ* themselves there is a series of larvæ,

which, starting with *Alima gracilis*, with its short carapace and elongated hind body, leads, through many intermediate types, to a larva which is short and wide, and almost completely covered by the elongated carapace, like an *Erichthus*, although its general structure is *Alima*-like. For this larva, which he justly regards as the ancestral form from which the *Alima* larvæ have been produced, Claus proposes the provisional generic name *Alimerichthus*, as expressing its double relationship, to *Alima* on the one hand, and *Erichthus* on the other.

He figures[1] a single advanced larva of this type 18 mm. long from the Indian Ocean, but as he gives no account of its early stages, the occurrence in the Challenger collection of younger specimens of this type is a matter of great interest, as these younger larvæ show that the young *Alimerichthus*, like the young *Alima*, passes through a stage in which the last six thoracic somites have no appendages, while the raptorial limbs of the second thoracic somite and the first pairs of abdominal appendages are well developed and essentially like those of the adult.

I have selected from a collection made, February 29, 1886, in the South Atlantic, off the coast of South America, in lat. 36° 9′ 8″ S., long. 48° 22′ W., the two specimens which are shown in Pl. VIII. fig. 8, and Pl. IX. fig. 3, and which represent a form which is very closely related to, but probably not identical with the one figured by Claus. The youngest, shown in Pl. VIII. fig. 8, is 8·715 mm. long, and the next stage, shown in Pl. IX. fig. 3, is 15·52 mm. long, while Claus's *Alimerichthus* is 18 mm. long, so that we probably have, in this series, three successive moults in the history of the larva for which Claus's generic name may be retained without a specific name. *Alimerichthus* is characterised as follows—A short wide *Alima* with a short hind body which is wide and flat in the older larvæ. The mouth is near the middle of the carapace, and the rostrum is less than half as long as the carapace, which has a median dorsal spine, and moderately long antero- and postero-laterals. There is a secondary spine on the inner edge of the postero-lateral close to its base, and a very prominent acute spine projecting outwards from the lateral edge of the carapace, about midway between the bases of the antero- and postero-lateral spines, and two or three smaller ones projecting inwards between this and the one at the base of the postero-lateral. The length of the carapace, measured on the middle line, from the tip of the rostrum, makes much more than half the total length, and it covers all of the thorax except the tip of the eighth somite, while the tips of the postero-lateral spines are in the line of the anterior edge of the telson. The eye stalks are about as long as the eyes, which have swollen globular tips, the width of the carapace equals about one-third the total length, the telson is wider than long, with six marginal spines, and numerous secondary spines between the submedians and also between each submedian and the adjacent intermediate. The inner spine of the basal prolongation of the uropod is slightly longer than the outer,

[1] Metamorphose der Squilliden, p. 147, Taf. viii. fig. 30.

and there are few (five or six) marginal spines on the outer edge of its exopodite. In the older larvæ the dactylus of the raptorial limb shows traces of six spines besides the marginal one.

In the youngest *Alimerichthus* which has been observed (Pl. VIII. fig. 8) the flagellum of the second antenna is represented by a bud, as are also the appendages of the third thoracic somite, and the third, fourth, and fifth thoracic somites are crowded together so that the sum of their lengths is about equal to the length of each one of the three last thoracic somites, upon which there are no traces of appendages. There are five pairs of fully developed and functional abdominal appendages, and five distinct abdominal somites, the first four wider than the thorax, but the fifth very narrow and deeply constricted off from the telson, upon the anterior edge of which the sixth pair of abdominal appendages are represented by buds. The telson is wider than long, and nearly four times as wide as the abdomen. It has six pairs of marginal spines with numerous minute secondary spines between the submedians, ten or eleven on each side between the submedian and adjacent intermediate, and a single one internal to the base of the lateral. The margin of the telson, between the submedian and the intermediate, makes an angle of about 45° with the principal axis of the body. A comparison of this larva with the corresponding stage of *Alima gracilis* (Pl. IV. fig. 5), or of *Alima macrophthalma* (Pl. VIII. fig. 1), shows that there is every reason for believing that it is preceded by an earlier stage like the youngest observed stage of *Alima gracilis* (Pl. IV. fig. 4), of *Alima macrophthalma* (Pl. VII. fig. 2), or *Alima* (*Squilla*) *empusa* (Pl. I. fig. 4), and that at this time the third, fourth, and fifth thoracic somites are long and without appendages like the sixth, seventh, and eighth; the fifth abdominal somite and its appendages absent or rudimentary, the sixth absent, and the telson spatulate, with the submedians wide apart, and the secondary dentations between the submedians and intermediates about as large as the primary spines. As we know that some, and probably all, of the *Alima* larvæ hatch from the egg in this condition, and do not pass through a free *Erichthoidina* stage, this is undoubtedly true of the *Alimerichthus* also.

In the next stage which has been observed (Pl. IX. fig. 3) the appendages and somites are all present, the exopodites of the first five abdominal appendages carry at their bases the rudimentary buds which are to become the gills, the telson is shorter and wider than before, and the intermediate marginal spines have travelled backwards until the posterior margin of the telson is nearly transverse between them. The sixth abdominal appendages are still small, but in the next stage, the one shown in Claus's fig. 30, they are nearly as long as the telson, with six or seven marginal spines on the outer edge of the exopodite and with the inner spine longer than the outer, with an obscure lobe on its outer margin near the base. The whole hind body is now wide and flat, and there are indications of five or six marginal spines on the inner edge of the dactylus of the raptorial claw.

I have shown that the *Alima* larva resembles the adults of the genus *Squilla* in the depression of the hind body, the presence of marginal spines on the dactylus of the raptorial claw, in the small number of marginal spines on the outer edge of the exopodite of the uropod, in having its inner spine longer than the outer, with a lobe or dentation on its outer edge, and in the presence of numerous secondary spines between the submedian spine and the intermediate marginal spine of the telson.

In all of these respects *Alimerichthus* resembles *Alima*, and it is, therefore, beyond question, a *Squilla* larva, but it differs from *Alima* in the great width of its telson and the absence of spines on its abdominal somites, as well as in its resemblance to the more primitive *Erichthus* larva.

The comparative study of the adult Stomatopoda teaches that the genera *Lysiosquilla* and *Squilla* are two divergent branches from a common stem, and that the primitive *Squillæ* were more like this stem-form, and therefore more like *Lysiosquilla* than the more specialized species. In the genus *Squilla*, *Squilla* (*Chlorida*) *microphthalma* and its allies are the closest living representatives of the stem-form, and they resemble the lowest species of the genus *Lysiosquilla* in the small size and the approximation of the eyes, the small size of the antennæ and uropods, the loose articulation of the hind body, and the width of the telson. I shall show further on that the larva of *Lysiosquilla*, as well as of the more primitive genera of Stomatopoda, is an *Erichthus*, and that all the true *Alimæ* are *Squilla* larvæ. The common ancestor of *Lysiosquilla* and *Squilla* must therefore have passed through an *Erichthus* stage. If it be true that the characteristics of the *Alima* larva are the result of secondary modification, it is of course quite possible that the most modified adult *Squillæ* might have their larvæ the least modified, but in the absence of any proof that this is the case, it is more natural to believe that the most typical *Alimæ* are the young of the most typical *Squillæ*, and that *Alimerichthus*, the most primitive and *Erichthus*-like of the *Alimæ*, is the young of a smooth loosely articulated and primitive *Squilla*, like *Squilla* (*Chlorida*) *microphthalma*. While this conclusion cannot be accepted without question, in the absence of direct proof, there is much reason for believing that *Alimerichthus* is the larva of a *Squilla* closely related to *Squilla microphthalma*, and this decision receives added force from the fact that several of the most conspicuous peculiarities of *Alimerichthus* as distinguished from *Alima*, such as the width and shortness of the telson, and the loose articulation of the hind body, are points of resemblance to *Squilla microphthalma*. In the true *Alimæ* the postero-lateral angles of the abdominal somites end in acute spines, which are not developed in *Alimerichthus*, and, as *Squilla microphthalma* is the least costate of the true *Squillæ*, this is another point of resemblance. It is not probable, however, that *Alimerichthus* is specifically identical with *Squilla microphthalma*, and future research may prove that its adult form is an unknown and still more primitive *Squilla*.

*The Lysioerichthus larva, and the Metamorphosis of Lysiosquilla.*

If my decision that all the *Alima* larvæ are young *Squillæ* be correct, we must look for the larvæ of all the other genera of Stomatopoda among the *Erichthi* and *Squillerichthi;* or, as *Squillerichthus* is simply an advanced *Erichthus*, among the *Erichthi.*

The series of *Erichthus* larvæ is so complete, and transitional forms are so numerous, that it is very difficult to divide the group into minor groups; and while it is obvious that there are several distinct larval types, they are so intimately united by intermediate forms that the attempt to study them is very puzzling. The genera merge into each other in such a way that it is difficult to find any strictly diagnostic characteristics, but this is no more than we should expect from the absence of sharply limited genera among the adult Stomatopoda.

I have shown that the species of *Lysiosquilla*, in which genus I include *Coronis*, and the species of *Squilla* including *Chloridella*, exhibit proofs of divergent descent from a common stem form, which was more like *Coronis* and *Chloridella* than it was like the more divergent *Lysiosquillæ* and *Squillæ;* and as I have also shown that the larvæ of all the species in the *Squilla*-branch from this common stem are *Alimæ*, we naturally turn to the *Alima*-like *Erichthi* in our search for the larval type of the second or *Lysiosquilla*-branch.

In addition to their features of relationship to the adult genus *Squilla*, the *Alima* larvæ agree with each other in the general occurrence of marginal spines on the lateral edges of the carapace, the length of the telson, which is almost always greater than its breadth, the flatness of the hind body and the presence of marginal spines on the inner edge of the dactylus of the raptorial claw. *Squilla* and *Lysiosquilla* agree with each other in the flatness of the hind body, and in the presence of spines on the dactylus, but the *Alima* larva shows its relationship to *Squilla* by the presence of numerous secondary spines between the submedian and intermediate marginal spines of the telson, by the small number of spines on its dactylus, and by the fact that the inner spine of the uropod is always longer than the outer.

Now there is a group of *Erichthus* larvæ, of which *Erichthus duvaucellei* (*Lysiosquilla maculata ?*) (Pl. X. fig. 7), and *Erichthus multispinosus* (*Lysiosquilla excavatrix*) (Pl. XI. figs. 1, 2 and 3) are examples, which show by the flatness of the hind body, and by the presence under the cuticle of the dactylus, in the older larvæ, of traces of marginal spines, that they are either *Squilla* or *Lysiosquilla* larvæ. Claus refers them to the genus *Squilla*, but as the marginal spines are usually more numerous than they are in any known *Squilla* or in the *Alima* larva, we must exclude the genus *Squilla* in our attempt to trace them to their adult form. In some of these larvæ there are as many as seventeen of these rudimentary spines on the dactylus, and they are seldom less than six, and there

is ample internal evidence, drawn from other structural features, to show that they are *Lysiosquilla* larvæ; and in addition to this indirect but satisfactory evidence, I am now able to furnish more direct proof, as I have reared a *Lysiosquilla*, *Lysiosquilla excavatrix*, from one of those larvæ (Pl. X. figs. 14, 15), and one of the Challenger specimens (Pl. X. fig. 7) exhibits the characteristic transverse pigment stripes and other specific characteristics of *Lysiosquilla maculata*, while another advanced larva of this type (Pl. XI. figs. 6, 8, 9) exhibits the flattened oval thin membraneous appendages to the exposed thoracic limbs which is characteristic of the lower *Lysiosquillæ*.

This larval type, for which I propose the provisional generic name *Lysioerichthus*, merges into the *Erichthus* of *Gonodactylus* and that of *Pseudosquilla* in such a way that it is often difficult to decide whether a certain larva is to be referred to the one or the other of these groups, but the *Lysioerichthus* may usually be distinguished from the other *Erichthi*, by the position of the postero-lateral spines of the carapace, which, when seen in profile (Pl. X. figs. 7, 14; Pl. XI. figs. 2, 3) are separated by a wide interval from the dorsal middle line; they are either on the ventral edge of the carapace or else they are much nearer to it than to the dorsal middle line, while the reverse is the case in the *Erichthus* of *Pseudosquilla* (Pl. XII. fig. 6) and that of *Gonodactylus* (Pl. XV. figs. 11, 12). In addition to this feature, which is, I believe, strictly diagnostic, they are also characterised among the *Erichthi* by the width and flatness of the hind body, and by the great depth of the carapace, the lateral edges of which are ventrally infolded, as shown in the figures.

During their younger stages they exhibit a most striking resemblance to the *Alima* larva (Pl. XI. fig. 1; Pl. XII. fig. 4), although this resemblance is entirely lost by the older larvæ.

In addition to the greater number of spines on the dactylus of the raptorial claw they are also distinguished by other features, all of which indicate their identity with *Lysiosquilla*. The telson is wider than long, like that of *Lysiosquilla*, and unlike that of *Alima* and *Squilla*, where it is, almost without exception, longer than wide; and between its intermediate and submedian marginal spines there is usually only one secondary spine, and never more than four. This is true of the adult *Lysiosquilla* also, while in all the adult *Squillæ* and all the *Alimæ* the secondary spines are more numerous.

The outer one of the two spines at the end of the ventral prolongation from the base of the uropod is, with rare exceptions, longer than the inner, as is the case, also with rare exceptions, in *Lysiosquilla*, while the reverse is true without any exception in *Alima* and in *Squilla*.

The *Lysioerichthus* is a true *Erichthus*, although it is the most *Alima*-like of the *Erichthi*. Like the *Alima* the young *Lysioerichthus* has numerous marginal spines on the lateral edges of the carapace, although this characteristic disappears as the larva grows older, while it is retained by the fully grown *Alima* larva. In the very young

stages of both types the thoracic region is elongated; there are no traces of appendages on the last six thoracic somites; the hind body is elongated and narrow, and the carapace shallow and flat. This general resemblance to an *Alima* disappears with the growth of the larva, and the fully grown *Lysioerichthus* is not at all *Alima*-like, as its body is short and wide, and the carapace so deep that it covers the sides and part of the ventral surface of the free body, while the hind body also may be bent forwards and entirely covered by the carapace.

These *Erichthi* with a deep carapace and a wide flat hind body are very numerous and widely distributed, and as they are also among the largest of the Stomatopod larvæ we may be confident that they pertain to adults which belong to a widely distributed genus, including many species, some of which are among the largest Stomatopods.

While we cannot feel at all confident that all the genera of adult Stomatopoda are known, it is highly improbable that these larvæ belong to an unknown genus, and we may safely refer them to one of the well known genera. Their large size and the presence of marginal spines on the dactyle exclude *Protosquilla* and *Gonodactylus*, and the depression of the hind body excludes *Pseudosquilla*, and we must therefore refer these larvæ to either *Squilla* or *Lysiosquilla*.

Claus, as I have pointed out, advocates the first view, but the description which follows will show that there is ample internal evidence that they are all *Lysiosquilla* larvæ, and this indirect evidence is rendered all the more conclusive by the fact that I have reared *Lysiosquilla excavatrix* from one of them, while the Challenger collections enable me to trace another to *Lysiosquilla maculata* with nearly equal certainty.

I therefore feel sure that the examination of the descriptions which follow will furnish convincing proof that all these *Erichthi* are young *Lysiosquillæ*, and that all the *Lysiosquillæ* pass through the *Lysioerichthus* stage.

The *Erichthus* larva shown in Claus's figure 14 is very similar to *Lysioerichthus*, but it differs from them all in features in which they all agree with each other, and I shall give farther on my reasons for believing that it is a *Coronida* larva, and therefore equally related to both *Alima* and *Lysioerichthus*.

As I shall soon show, there is reason for distrusting the accuracy of his drawing of the telson of his *Erichthus multispinosus*, which is also exceptional.

*Lysiosquilla* (*Erichthus*) *excavatrix*.—At Beaufort, N.C., U.S.A., where only two species of Stomatopoda, *Squilla empusa* and *Lysiosquilla* (*Coronis*) *excavatrix*, are known to occur, and where both species are abundant, two types of Stomatopod larvæ are also abundant, and as there is ample evidence to show that one of these, shown in Pl. I. fig. 4, is the young of *Squilla empusa*, it is natural to infer that the other (Pl. XI. figs. 1, 2, 3) is the larva of the Beaufort *Coronis*, *Lysiosquilla excavatrix*, of which Pl. X. fig. 8 represents the adult male. Nearly all the larvæ which I found were in the stage shown in Pl. XI. fig. 1, and all my attempts to rear them in captivity failed, as

they all died in moulting. The newly hatched young are swept out to sea by the tide, and are widely distributed, and the older larvæ are seldom found at Beaufort, but I have procured a few specimens which serve to connect the youngest stage with a larva nearly an inch long, which changed in the house into a young *Lysiosquilla excavatrix*, so that there is little doubt that all the larvæ of this type found there belong to this species.

The youngest larva which is figured is very similar to Claus's *Erichthus multispinosus* from the Indian Ocean, although it is much younger, nor do they belong to the same species, for Claus's specimen has eight or nine, and ours only three, secondary spines between the intermediate and the submedian marginal spines of the telson, although in other particulars there is the closest resemblance between the two.

It has four distinct well-developed abdominal somites with appendages, while the short fifth abdominal somite is not yet separated from the telson. The flagellum of the second antenna and the appendages of the last six thoracic somites are absent, although the somites are present and equal in length, with the exception of the eighth, which is longer than the others. The rostrum is about as long as the carapace, and it has two or three small spines on its lower surface. The carapace covers all the thoracic, but not the abdominal somites, and its general outline, in dorsal or ventral view, is nearly square, but its length slightly exceeds its greatest width, and its width between the bases of the antero-lateral spines is less than between the bases of the postero-laterals. In profile view (fig. 2) the lateral edges are bent downwards below the level of the ventral surface of the thorax, and the chamber which is thus formed is deepest at its posterior edge, so that the mid-dorsal outline and the lateral edge are wide apart posteriorly, and approach each other in an acute angle at the base of the rostrum. On the middle line of the posterior edge there is a slender spine a little shorter than the rostrum, and about equal in length to the curved, divergent postero-laterals, each of which carries a secondary ventral spine near its base, dorsal to which, on the posterior edge of the carapace, there is a small secondary spine on each side, as well as one on the lateral edge posterior to the base of each of the long, divergent and widely separated antero-laterals, and on the lateral edge about halfway between the antero- and postero-laterals there are two secondary spines. The telson is considerably longer than wide, with its posterior edge nearly transverse, its anterior edge narrow, and with six marginal spines on each side, the first, which is longer than the next five, becoming the lateral marginal spine of the adult, is separated from the second or intermediate by a wider space than those between the others. The eye-stalks are about as long as the eyes, which are narrow with globular tips. The raptorial claw is flat and oval, and there is a large prominent spine close to the proximal end of the carpus.

The next larva which is shown as seen from the left and below (fig. 3) is considerably older and larger, and the marginal spines of the rostrum and carapace have

increased in size and in numbers. The sides of the carapace are folded down over the body more than they are in the younger larvæ, and the median dorsal spine is relatively shorter. The appendages of the third, fourth, and fifth thoracic somites are represented by buds, as well as the fifth abdominal appendages, and the three last thoracic somites are now longer than those in front. While I obtained a number of specimens of this stage I found only one older one, which moulted, before I had an opportunity to draw it, into the young *Lysiosquilla excavatrix*, shown in Pl. X. fig. 13, although I was able to make from the moulted skin the drawings of the carapace and telson which are given in figs. 14, 15, and 16, of Pl. X.

Although this larva, the carapace of which was $\frac{12}{20}$ inch long on the middle line, including the rostrum, and $\frac{6}{20}$ inch wide between the bases of the postero-lateral spines, is many stages older than the one last described, the differences are so very great that I at first doubted whether they could belong to the same series, but the consecutive series of stages in the growth of the closely related larva which is described in the next section furnishes satisfactory proof that this is the case. The antero-lateral and dorsal spines are now very short, although the rostrum and postero-laterals are of about the same relative length as before, and none of the marginal spines were visible with the hand-lens under which the drawings were made, except one in front of the base of each postero-lateral and one in front of this by one-third of the distance to the small antero-lateral. The telson (fig. 16) is now nearly rectangular, a little ($\frac{7}{6}$) wider than long, with very long submedian spine, and a nearly transverse but notched posterior border carrying thirty-six small secondary spines with very minute spinules between them. As compared with the submedians the other marginal spines are very small; the laterals are posterior to the middle line and have each a small spinule internal to the base, and one of the three secondary spines which were present in the younger larva has disappeared, while the second is very small, and the third much smaller than the intermediate. The change which takes place between this stage and the next, in the shape of the telson, is fully as great as the difference between the telson at this stage and that of the very young larva, as immediately after the moult the young *Lysiosquilla* has a telson essentially like that of the adult shown in Pl. X. fig. 8, transverse, and about twice as wide as long, with no secondary spines, and with all six marginal spines on the transverse posterior border, and the submedians united in a single median process, as shown in fig. 13.

I am inclined to believe that a small *Erichthoidina* larva, which is occasionally, although very rarely, found on the eastern coast of the United States, is the larva of this species. Faxon has found one of these larvæ at Newport, R.I., and he has figured it in pl. viii. figs. 11 and 12 of his selection from Embryological Monographs.[1] Through the courtesy of Professor Baird I have also had an opportunity to examine a sketch of another specimen which Professor S. J. Smith obtained at the United States Fish Commission

[1] *Bull. Mus. Comp. Zool.*, vol. ix. 1, 1882.

laboratory at Wood's Holl, and I have found one specimen at Beaufort, although sickness in my family prevented me from studying, and my hope of rearing it from preserving it. It died, however, without moulting, like all the young Stomatopod larvæ which I have tried to rear in captivity. It is essentially like the *Erichthoidina*, from Honolulu, shown in Pl. XII. figs. 1, 2, and very similar to Claus's *Erichthoidina gracilis*[1] and *Erichthoidina armata* (fig. 3), and it differs from the *Erichthoidina*, shown in Pl. XII. fig. 3, and from Claus's *Erichthoidina brevispinosa*, which I hold to be young *Gonodactyli*, in the absence of a spine below the base of the postero-lateral, and in the greater relative distance between this spine and the dorsal spine.

I shall give reasons for believing that these differences are characteristic of the *Lysiosquilla Erichthus* as distinguished from the *Erichthus* of *Gonodactylus*, and as we find two corresponding types of *Erichthoidina* it is natural to believe that one becomes converted at last into a *Lysiosquilla*, and the other into a *Gonodactylus*.

I therefore regard Claus's *Erichthoidina gracilis* and *Erichthoidina armata*, the Challenger *Erichthoidina* from Honolulu (Pl. XII. figs. 1, 2), Faxon's larva and Smith's larva as very young *Lysiosquillæ*, and Claus's *Erichthoidina brevispinosa* and the Challenger *Erichthoidina*, from St. Vincent (Pl. XII. fig. 3), as young *Gonodactyli*, for reasons which will be more fully developed in the sequel. If this is true we have a most striking corroboration of the correctness of the opinion so ably and ingeniously advocated by Claus (Crustaceen System) that the Stomatopod larva without appendages upon the last six thoracic somites, in which condition the *Alima* larva leaves the egg, is the phylogenetic descendant of a larva with biramous feet on all these somites, for this change must actually occur during the ontogenetic development of *Lysiosquilla excavatrix*, since Faxon's and Smith's larvæ have biramous appendages on the third, fourth, and fifth of these somites, like those on the first and second, although the youngest *Lysioerichthus*, shown in our figure has no traces of them on these somites, or upon the sixth, seventh, and eighth.

The great rarity of *Erichthoidina* larvæ may possibly be due to the fact that during this early period of its larval life, the young Stomatopod remains within the burrow of its parent, or it may be that the larva does not usually escape from the egg until this stage is passed, and that the few specimens which are met with at rare intervals are those which have been prematurely hatched.

The analogy of other Crustacea, the various species of *Alpheus*, for example, shows that two closely related species may hatch in different stages, and it is therefore possible that one *Erichthus* may hatch as an *Erichthoidina*, while another hatches in the *Erichthus* stage. It is not impossible that some *Alimæ* may hatch as *Erichthoidinæ*, although there is no evidence that this is the case.

Before I enter upon the general discussion of the *Lysioerichthus* I will describe

[1] Metamorphose der Squilliden, Taf. i. figs. 1, 2.

a few larval formss elected from the numerous Challenger specimens which I refer to this genus, or to the subgenus *Coronis*.

*Coronis* (*Erichthus*) *minutus*.—From a collection of larvæ taken in the tow-net at St. Vincent I have selected the series which is shown in Pl. XII. fig. 4; Pl. XIII. figs. 1–8, and 11, all of which undoubtedly belong to a single species. This is shown by their general resemblance and also by the accompanying table of measurements. The length of the four specimens, measured from the tip of the rostrum to the tip of the telson, are as follows:—

| | No. 1. 4·16 mm. | No. 2. 5·29 mm. | No. 3. 6·49 mm. | ... | No. 4. 10·21 mm. |
|---|---|---|---|---|---|
| If the length of No. 1, which is 4·16 mm. be successively multiplied by $\frac{5}{4}$, we shall have the following series of numbers, . | 4·16 | 5·20 | 6·50 | 8·13 | 10·16 |

and the close agreement between the measured and the computed length shows that Nos. 1, 2, and 3, are successive stages, and that there is a stage which is not represented in the collection between Nos. 3 and 4, and that the length of the larva increases uniformly at each moult by one-fourth of its length before the moult. It is hardly conceivable that an accidental collection of unrelated specimens should show such close conformity to a numerical law, and we may safely decide that the larva shown in Pl. XII. fig. 4 becomes transformed, through the stages described, into the one shown in Pl. XIII. fig. 7. This latter larva is so similar to the larva of *Lysiosquilla* (*Coronis*) *excavatrix* that the series from St. Vincent may also be safely referred to an adult of the subgenus *Coronis* of the genus *Lysiosquilla*. It does not seem to have been described, and on account of its small size, I propose for it the provisional name *Erichthus* (*Coronis*) *minutus*.

The diagnostic characteristics of this species are as follows:—A small *Erichthus* with a broad flat hind body, a rostrum less than half as long as the carapace, and with the postero-lateral spines of the carapace ventral, and without a tooth ventral to their base; the raptorial claw (Pl. XIII. fig. 11) is flat and oval, and there is one large spine on the anterior edge of the carpus close to its proximal end. The telson has six primary marginal spines, the intermediates larger than the laterals and having a minute secondary spinule internal to their bases, and one small secondary spine between the intermediate and the submedian. The outer margin of the exopodite of the uropod has few spines, and the basal prolongation ends in a long slender acute outer spine with a broad base, and a very small inner spine. The carapace with the rostrum makes a little more than half the total length, and its posterior edge, which has a small

median dorsal spine, crosses the middle line above the posterior edge of the first abdominal somite. The eyes are nearly cylindrical, with very short stalks, and the hind body is flat and wide.

The youngest larva (No. 1, shown in Pl. XII. fig. 4) is so similar to the one represented in Claus's figure 22 B, that we must believe that they are closely related. The Challenger larva from St. Vincent is 4·16 mm. long, and our measurements indicate that, if there be a younger stage, its length should be 3·33 mm., while Claus's larva, from Messina, is about 3 mm. long, and it is highly probable that it belongs to this species, and is therefore a *Coronis*, although this author held that it is either a *Pseudosquilla* or an *Alima*.[1] The spines of the carapace are longer, and the eyes longer and narrower in our species than in Claus's figure, but these are the greatest differences.

In our larva No. 1 (Pl. XII. fig. 4) the first antennæ have only two branches, the second antennæ have no flagellum, and the third, fourth, fifth, sixth, seventh, and eighth thoracic somites have no traces of appendages, and they are equal in length, although the eighth is wider than the others. The thoracic ganglia are marked off by fissures but they are in contact with each other.

There are five distinct abdominal somites with separate ganglia and functional appendages, each with an appendix interna or retinaculum on the thoracic edge of its endopodite (Pl. XII. fig. 4).

The sixth abdominal somite is obscurely indicated, and its appendage is represented by a bud (Pl. XIII. fig. 1). The carapace has a small dorsal median spine on its posterior edge, the rostrum is about half as long as the carapace, with three small spines on its ventral surface, and about as long as the divergent postero-lateral spines. The lateral edges of the oval carapace are fringed with numerous minute serrations, but there is no large tooth on the ventral side of the base of the postero-lateral spine. The raptorial claws, even at this early stage, are flat and wide, and the carpus has a single prominent tooth close to its base, on its anterior edge.

A profile view of the next stage (No. 2) is given in fig. 11 of Pl. XIII. A small bud now represents the flagellum of the second antenna (Pl. XIII. fig. 4), and the appendages of the third, fourth, and fifth thoracic somites are also represented by buds (Pl. XIII. fig. 5), and the ganglia of the sixth, seventh, and eighth thoracic somites have separated from each other. The sixth abdominal ganglion and somite are now distinct, and the rudimentary appendage (Pl. XIII. fig. 3) consists of a long acute simple spine and two rounded lobes. The posterior edge of the telson, which was transverse in stage 1 is now angulated on the middle line. The next stage is shown from below in Pl. XIII. fig. 6. All the appendages and somites are now represented, the lateral

[1] Metamorphose der Squilliden, p. 144.

edges of the carapace are folded inwards, and the minute inner spine has appeared upon the ventral process of the uropod. The abdomen is now flat and wide and the lateral edges of the fifth somite are acute.

The single specimen of the oldest stage (No. 4) was so badly preserved that many points were obscure. It is shown in ventral view in Pl. XIII. fig. 7. The abdomen is wide and flat, the lateral edges of the carapace are folded in, and the basal process of the uropod is as long as the telson, which is deeply angulated on the middle line (Pl. XIII. fig. 8). The secondary single spine between the submedian and the intermediate is now much smaller than the latter, which has a minute spinule internal to its base. The raptorial claw is flat and oval as it is in the adult *Coronis*.

The striking resemblance which Claus points out between the early stages of this larva and a young *Alima* larva are superficial, since it is a true *Erichthus*, with the ocular and antennary somites covered by the rostrum, the carapace folded downwards and inwards at the sides, the outer spine of the basal prolongation of the uropod longer than the inner, and only one instead of several secondary spines between the submedian and the intermediate spines of the telson.

While there are numerous specific differences between it and the larva of *Coronis excavatrix*, a comparison of the various stages in the development of the two larvæ will show their very close similarity, and there can be no doubt that this also is a *Lysiosquilla*, and it probably belongs to the subgenus *Coronis* also.

Claus figures several advanced larvæ which agree with this one in the depression of the hind body, the number and relative size of the marginal spines on the telson, the

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|---|---|---|---|
| Measurements on middle line :— | | | | | | | | |
| Rostrum from tip to anterior edge of ocular somite, | ·80 | 1·04 | 1·25 | 1·99 | 192 | 197 | 193 | 195 |
| From anterior edge of ocular somite to tip of labrum, | ·32 | ·41 | ... | ·75 | 77 | 77 | ... | 73 |
| From tip of labrum to posterior edge of carapace, | 1·12 | 1·44 | 2·50 | 2·49 | 269 | 272 | 385 | 244 |
| From posterior edge of carapace to posterior edge of telson, | 1·92 | 2·40 | 2·74 | 4·98 | 462 | 454 | 422 | 488 |
| Total length on middle line, | 4·16 | 5·29 | 6·49 | 10·21 | 1000 | 1000 | 1000 | 1000 |
| Width of carapace between bases of postero-lateral spines, | ... | ... | ... | 2·16 | ... | ... | ... | ... |
| Width of fourth abdominal somite, | ... | ... | ... | 1·76 | ... | ... | ... | ... |

shape and character of the uropod, the width of the raptorial claw, the position of the postero-lateral spines of the carapace and other features, and as he has also been able to show that the dactylus of the raptorial claw of the older larvæ is bordered by

numerous marginal spines, there is little doubt that they are *Lysiosquilla*, pretty closely related to the two which have been described. One of these, an *Erichthus* 14 mm. long, from Bengal,[1] he himself refers to the subgenus *Coronis*, and his *Squillerichthus triangularis* (fig. 13) and possibly his *Erichthus latreillei* (fig. 18) are closely related species.

The Challenger collection contains many specimens of a number of species of this larval type, some of them very broad and short, and others as narrow as a *Gonodactylus Erichthus*, from which they are distinguished by the position of the postero-lateral spine of the carapace, which is either on the ventral edge or nearer to it than to the dorsal middle line, while the reverse is the case in the *Gonodactylus* larva, which also has its hind body convex instead of flat.

One of these *Lysioerichthus* larvæ from a surface collection made by the Challenger at Papua, Japan, is shown in Pl. XI. figs. 10, 11, 12, and 13. It is $\frac{9}{10}$ of an inch long on the middle line, with a minute dorsal spine, a rostrum which is nearly as long as the carapace, small antero-laterals, and postero-laterals which spring from the carapace close to its ventral edge, and reach backwards as far as the middle of the sixth abdominal somite, while all the abdominal somites except the first are exposed on the middle line. The raptorial claw (fig. 13) is flat, broad and oval, and its dactylus shows under the cuticle traces of eight marginal spines. The hind body is as wide as the carapace, and the telson (fig. 11) is much wider than long, with its posterior border angulated and fringed with numerous small spinules between the submedians, the distance between which is about half the greatest width of the telson. There is a small spinule internal to the base of each lateral and each intermediate marginal spine, and one small secondary spine between the intermediate and submedian.

| | |
|---|---|
| Length of carapace including rostrum, . . . . | ·48 inch. |
| Length of exposed somites and telson, . . . . | ·42 „ |
| Total length on middle line, . . . . . | ·90 „ |
| Length of postero-lateral spines, . . . . . | ·26 „ |

The oval shape of the flattened carpus indicates that this larva is a *Coronis*. There is a general resemblance between it and the one last described, but the raptorial claw is less oval, and in a third closely related larva, collected between Sydney and Wellington, the raptorial claw is still more elongated. This latter larva, which is shown in Pl. IX. figs. 6, 7, 8, 9, and 10, is so similar to the one shown in Claus's figure 20, that they must represent related adults, and I am therefore compelled to dispute his identification of his larva as a young *Gonodactylus*.

It is remarkable for the great length of the rostrum and postero-lateral spines, the

[1] Metamorphose der Squilliden, fig. 19.

latter reaching beyond the tip of the extended telson. The carapace has a long median dorsal spine, and it exposes the posterior half of the third abdominal somite.

| | |
|---|---|
| Length of carapace on middle line including rostrum, | ·50 inch. |
| Length of exposed hind body, | ·20 „ |
| Total length from tip of broken rostrum, | ·70 „ |
| Length from tip of rostrum to tip of postero-lateral spines, | ·78 „ |
| Width of carapace between bases of postero-lateral spines, | ·26 „ |
| Width of hind body, | ·16 „ |

In addition to the larvæ which have been described, the Challenger collection contains numerous specimens from various localities, which must represent closely related adults. It also contains specimens of two somewhat peculiar larval types, which join to their distinctive characteristics so many features which are shared by all the *Lysioerichthus* larvæ that I place them in this group.

One of them, which is represented by several specimens from Rio Janeiro, is shown in profile view in Pl. IX. fig. 11, and in dorsal view in Pl. XI. fig. 6, while the telson, the raptorial claw, and the seventh thoracic limb are shown in figures 7, 8, and 9. It is a little younger than Claus's *Squillerichthus triangularis*,[1] but it belongs to the same or a closely related adult. The dactylus of the raptorial claw of the oldest specimen in the Challenger collection is smooth, but in Claus's larva six marginal spines were visible underneath the cuticle. This, as well as the width and flatness of the hind body, the depth of the carapace, and the ventral infolding of its lateral edges, and the shape of its telson and uropods (fig. 7) show its close relationship to the *Lysioerichthus* larvæ which have already been described, and the flat oval raptorial claw (fig. 8) and the dilated oval scale-like form of the appendages to the exposed thoracic limbs of the older larvæ (fig. 9), indicate that the adult is one of the lower or *Coronis*-like species of the genus *Lysiosquilla*. In Claus's larva, which is slightly more advanced than the oldest one in the Challenger collection, the raptorial claw exhibits under the cuticle indications of six marginal spines, and this author therefore regards it as the young of one of the six-spined species of *Squilla* (p. 131). The fact that the young *Lysiosquilla excavatrix* has a smaller number of marginal spines than the adult male, shows that the presence of six spines in the larva is no evidence that they are not more numerous in the adult, and while it is true that most of the adult *Lysiosquillæ* have more than six spines, and that some of them have less, there are several species in which the adult has only six. Claus says (p. 131) that the telson of this larva exhibits the *Squilla*-type, but as all known species of *Squilla* and all the *Alima* larvæ have numerous secondary marginal spines between the submedian and intermediate marginal spines of the telson, while our specimens, as well as the one figured by Claus, have only one such secondary spine, its relationship is obviously with *Lysiosquilla* rather than *Squilla*.

[1] Metamorphose der Squilliden, fig. 13.

A second very remarkable larva, characterised by the great elongation of all the spines of the carapace, especially the antero-laterals, I refer, with less confidence, to the *Lysioerichthus* group. The single specimen, which is shown in Pl. XI. fig. 14, was taken in the tow-net off Kandavu Island, Fiji.

*Lysiosquilla maculata* (*Erichthus duvaucellei*) Guérin.—The largest *Erichthus* in the Challenger collection is shown in profile in Pl. X. fig. 7, and from below in Pl. XI. fig. 4. The collection contains numerous specimens which differ from each other only in the length of the dorsal spine, which is often entirely absent, sometimes present but very short, and occasionally well developed, as in the specimen from which fig. 7 was drawn. The various specimens are so much alike in all other particulars that I cannot believe that the length of this spine can be taken as an index of specific identity. It is probable that in the older larva at least it is often broken off in moulting, and that the differences in its length are accidental.

The largest specimens, which are more than one inch long, were collected between Api and Cape York, between Admiralty Island and Japan, in the Straits of Mendino, and at other points in the West Pacific. It is apparently the same as the *Erichthus duvaucellei* which Guérin obtained in the Gulf of Bengal, and Claus in the Indian Ocean. Although Claus states (p. 135) his opinion that it is a *Squilla* larva, it is clearly a *Lysioerichthus*, closely related to the various larvæ which have been described. In the larger specimens the integument of the carapace and of the abdominal somites is soft, flexible and leather-like, as in *Lysiosquilla maculata*, and the edges of the somites of the hind body exhibit the transverse dark bands which are so characteristic of this species. The inner spine of the basal prolongation of the uropod is longer than the outer, a relation which is somewhat exceptional among the *Lysioerichthus* larvæ, and also among the adult *Lysiosquillæ*, although the adult *Lysiosquilla maculata* is one of the exceptional species, having the inner spine longer than the outer. The raptorial claw of the larva is long and slender, with traces under the cuticle of eight marginal spines, and as the adult female *Lysiosquilla maculata* has seven or eight, while this number is increased in the adult male to nine or ten, I cannot doubt that this large, flat, soft, transversely striped, widely distributed larva, is the young of the largest of the Stomatopoda, *Lysiosquilla maculata*, which is also flat, transversely striped, soft, and very widely distributed.

### *The Larva of the genus Coronida.*

I have shown that we are led by the comparative study of the adult Stomatopoda, to believe that *Lysiosquilla* and *Squilla* are the divergent descendants of a *Protosquilla*-like form, with an acutely pointed rostrum, and minute uropods, and with the base of the dactylus of the raptorial claw dilated as in *Protosquilla* and *Gonodactylus*, but armed with marginal spines, and with the hind body depressed as it is in *Squilla* and *Lysiosquilla*,

and with a wide telson with the marginal spines on its posterior edge. For this genus I have proposed the name *Coronida*, and I have shown that we are acquainted with two species which are to be referred to it. If this phylogenetic generalisation be correct, we should expect the larva of this genus to unite in itself characteristics of both *Alima* and *Erichthus*, and to stand in somewhat the same relation to them as that which the adult *Coronida* bears to *Lysiosquilla* and *Squilla*. We should expect it to be a stem-form from which both of these larvæ may be derived. The Challenger collection contains no larvæ of this character, and so far as I am aware only a single specimen has been observed. This remarkable and interesting form, from the Atlantic, is shown in Claus's figure 14. It is much more advanced than any other *Erichthus* or *Squillerichthus* larva which has ever been described, resembling in this respect an *Alima* larva, and like the advanced *Alima* larvæ it has well developed gills, a long annulated flagellum on the second antennæ, a mandibular palpus, and its first five pairs of abdominal feet are, like those of the *Alima*-larva, more perfectly developed than in *Erichthus*, and it resembles all *Alima* larvæ and differs from all *Erichthus* larvæ in the presence of numerous (twelve) secondary spines between the intermediate and submedian spines of the telson. Like all *Alima* larvæ, and the young and a few of the old *Lysiosquilla Erichthus* larvæ, the lateral edges of the carapace are fringed with spines, but these edges are folded downwards and inwards, and in all other respects it is an *Erichthus*. The many points in which it resembles *Erichthus* and differs from all *Alimæ*, joined to many other points of resemblance to *Alima* and difference from all *Erichthi*, render it peculiarly interesting. It is so far advanced that it undoubtedly assumes its adult form after the moult which follows the stage shown in Claus's figure, and the adult rostrum with a long acute median spine is visible under the cuticle. As it has a wide flat hind body and spines in the dactyle it is not a *Protosquilla*, or a *Gonodactylus*, or a *Pseudosquilla*, and the long spine on the rostrum shows that it is neither a *Squilla* nor a *Lysiosquilla*. The telson is wider than long, its marginal spines are crowded backwards, the figure indicates that the sixth abdominal somite is probably fused with the telson, and the uropods are very small, and the two spines are very small and equal.

All its characteristics indicate that it is a very primitive and synthetic type, and while it may possibly belong to an unknown genus, all the indirect evidence which it furnishes indicates very strongly that it is either the larva of *Coronida*, or else of some closely allied form. I propose for it the provisional generic and specific names *Erichthalima synthetica*.

### *Pseuderichthus and the Metamorphosis of Pseudosquilla.*

Claus has traced to the adult *Pseudosquilla* a long narrow *Erichthus* larva which differs from *Lysioerichthus* in the shape of the carapace, which is narrow and short, and

also in the great length of the narrow hind body. His collection contained numerous specimens, all very similar in general appearance to the one which he traced to its adult form, from various localities in the Indian and Atlantic Oceans. They are all narrow and elongated and from 16 to 42 mm. long.

The Challenger collection also contains numerous specimens from many widely separated localities; all so similar to the one which Claus studied that they must pertain to closely related adults, and I therefore place them all in a provisional genus *Pseuderichthus*. One of them $1\frac{12}{100}$ inches long, from a collection made between Tenerife and St. Thomas, is shown in dorsal view in Pl. XII. fig. 6, while various parts of its body, more highly magnified, are shown in Pl. VI. figs. 2 and 6, and Pl. XIII. figs. 12 and 14. The telson and uropods of a very similar but much larger specimen, $1\frac{3}{4}$ inches long, from Volcano, are shown in Pl. VI. fig. 7. Another much smaller species, which undoubtedly belongs in the same group, although it is much wider and flatter than the one figured above, is shown in side view in Pl. V. fig. 4. It is $\frac{24}{50}$ inches long, and is from a gathering made between Api and Cape York. In all the older larvæ of this group the submedian spines of the telson are very long and slender, and are tipped with movable spinules, as in the adult *Pseudosquilla;* the proximal joint of the exopodite of the uropod is bordered by numerous (six to twelve) spines, the terminals are much longer than the others, and the dactylus of the raptorial claw often exhibits traces of two or three marginal spines under the cuticle. As all these characteristics are features of resemblance to the adult *Pseudosquilla*, and as Claus has obtained a very complete series of stages connecting one of these larvæ with an adult of this genus, there can be little doubt that they are all *Pseudosquilla* larvæ.

While it is very closely related to both *Lysioerichthus* and the *Erichthus* of *Gonodactylus*, and united to both these larval types by intermediate larval forms, I believe the following features may be relied upon as diagnostic of the *Pseuderichthus* larva. It is distinguished from the *Lysioerichthus* by the position of the postero-lateral spines of the carapace, which are near the dorsal surface; by the narrowness of the carapace, which is at least twice as long as wide, shallower than in *Lysioerichthus*, and not at all, or only very slightly, infolded along its lateral edges; by the elongation of the hind body, the length of the submedian spines of the telson, the presence of numerous spines on the outer edge of the proximal joint of the exopodite of the uropod, and the very great elongation of the outer one of the two ventral spines on its basal joint. It is distinguished from the *Erichthus* of *Gonodactylus* by the fact that the postero-lateral spines of the carapace are short, usually only one-fourth or one-third as long as the carapace, while they are usually more than half as long in the *Gonodactylus* larva, and also by the fact that the rostrum is usually short and compressed, and armed at about the middle of its ventral edge by a large acute curved spine, in front of which there are often two or three smaller spines.

The adult genus *Pseudosquilla* is not sharply limited, as the various species are very closely related to *Gonodactylus* on the one hand, and to *Coronida* and *Coronis* on the other, and we should not expect the larval type to be more definite than the adult, and as a matter of fact the collection contains larvæ which closely resemble *Pseuderichthus* although they may possibly be *Gonodactylus* larvæ, and others which may possibly be *Lysiosquilla* larvæ.

The Challenger collection contains very few young larvæ of this type, and I have not been able to trace its metamorphosis, although Claus has given reasons for believing that it hatches as an *Erichthoidina*, and afterwards undergoes a retrograde metamorphosis, loosing and afterwards redeveloping all the thoracic appendages, except the first and second pairs.

The *Erichthoidina* from St. Vincent, shown in Pl. XII. fig. 3, may possibly be a young *Pseudosquilla*, although it more closely resembles the *Gonodactylus Erichthus*.

### *The Gonerichthus larva and the Metamorphosis of Gonodactylus.*

The last larval type which I shall discuss is represented in the Challenger collection by numerous specimens, a few of which I have selected and drawn.

One of these, from St. Vincent, is shown in Pl. XII. fig. 5, while the telson and uropods of another specimen, from the Celebes Sea, in the same stage of development, and belonging to the same or a closely related species, are shown in Pl. XIII. fig. 9. The fully grown larva, $1\frac{28}{100}$ inches long, of another species from the West Pacific, lat. 17° 29′ N., long. 141° 21′ E., is shown in profile in Pl. XV. fig. 11, and from above in fig. 6, and the telson and uropods of a closely related species $1\frac{1}{5}$ inches long, from Volcano Island, in the West Pacific, are shown, more enlarged, in fig. 7.

The carapace of another species, $\frac{60}{100}$ inch long, from the Celebes Sea, is shown in Pl. XV. fig. 1, and the telson of a young *Gonodactylus* of the *Chiragra* type in the adult condition is shown in Pl. XVI. fig. 5. This specimen, which is $\frac{9}{10}$ inches long, was taken with the trawl in 18 fathoms, west of the Philippine Islands, at Station 208. This latter specimen had the raptorial claw fully developed, and it exhibited all the characteristics of the adult *Gonodactylus*. It is certainly a young *Gonodactylus* closely related to, or possibly a specimen of, *Gonodactylus chiragra*, and a comparison of its telson and uropods with those of the various larvæ which have just been noticed will show that there is the closest agreement in every particular. In all of these larvæ, as in the young *Gonodactylus*, the sixth abdominal somite has a pair of submedian spines near its posterior edge, and its postero-lateral angles are produced into acute spines. The telson is slightly wider than long, its submedian spines are long and slender, but shorter than they are in *Pseuderichthus*, and without the movable spinules of the latter. The telson is notched on the middle line, and there are from fourteen to twenty small secondary spinules on

its posterior edge, between the submedians. There is one small secondary spinule internal to the base of the lateral marginal spine, another internal to the base of the intermediate, and a third midway between this and the submedian. In figs. 7 and 8 as in the young *Gonodactylus* the outer edge of the proximal joint of the exopodite of the uropod is fringed by nine marginal spines, the terminal one longest, and the outer spine of the basal prolongation is much longer than the inner, but not as long as it is in *Pseuderichthus*. A comparison of the telson of the young *Gonodactylus* with that of the other larvæ which are figured in this paper, will show that none of them except those now under discussion exhibit this resemblance. The *Gonerichthus* larvæ which are here figured are all of them well advanced, and are furnished with large compound gills on their abdominal feet; this, together with the perfect development of their uropods, shows that they are nearly mature, and about ready to moult into the adult form, and as none of them exhibit any traces of marginal spines on the dactylus of the elongated slender raptorial claw, we may feel confident that the adults belong to a genus in which the dactylus is unarmed. It is not probable that a larval type which is so common pertains to an unknown adult genus; the larvæ are not *Protosquillæ*, as the sixth abdominal somite is well developed, and as they have no movable spinules on the tips of the submedian spines of the telson they are not *Pseudosquillæ*. The only remaining genus is *Gonodactylus*, and their structural characteristics all indicate that they are the young of species in this genus. Claus, who has figured two of these larvæ in his figures 21 A. and 21 A′. correctly refers them to *Gonodactylus* (p. 139) although he also refers to this genus two larvæ, figures 20 and 21 B. which are not *Gonerichthi* but *Lysioerichthi*, as he indeed suspects may be the case with the second one, 21 B.

The *Gonerichthus* larva may be distinguished from the *Lysioerichthus* by the shallowness of its carapace, which is not at all infolded, and by the position of its postero-lateral spines, which arise very close to the dorsal middle line. It is distinguished from the *Pseuderichthus* larva by the length of these spines, which are at least half as long as the carapace, and also by the fact that the telson is wider than long, and longer than the long outer spine of the uropod.

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# PLATE I.

## PLATE I.

### Squilla.

Fig. 1. *Squilla leptosquilla*, n. sp., from the Celebes Sea. Dorsal view of a male specimen, twice the natural size (p. 30).

Fig. 2. *Squilla leptosquilla*. Endopodite of first abdominal appendage of male; magnified. A, basal joint; B, terminal joint; *a*, outer lobe; *b*, inner lobe; *c*, suture; *d*, retinaculum; *e*, fixed limb of petasma; *f*, moveable limb of petasma.

Fig. 3. *Squilla quinquedentata*, n. sp., from the Marquesas Islands. Male specimen; natural size (p. 26).

Fig. 4. *Squilla empusa*, from Beaufort, N. C. Ventral view of young *Alima* larva, 3·216 mm. long (pp. 90, 101).

Fig. 5. Profile view of the same larva.

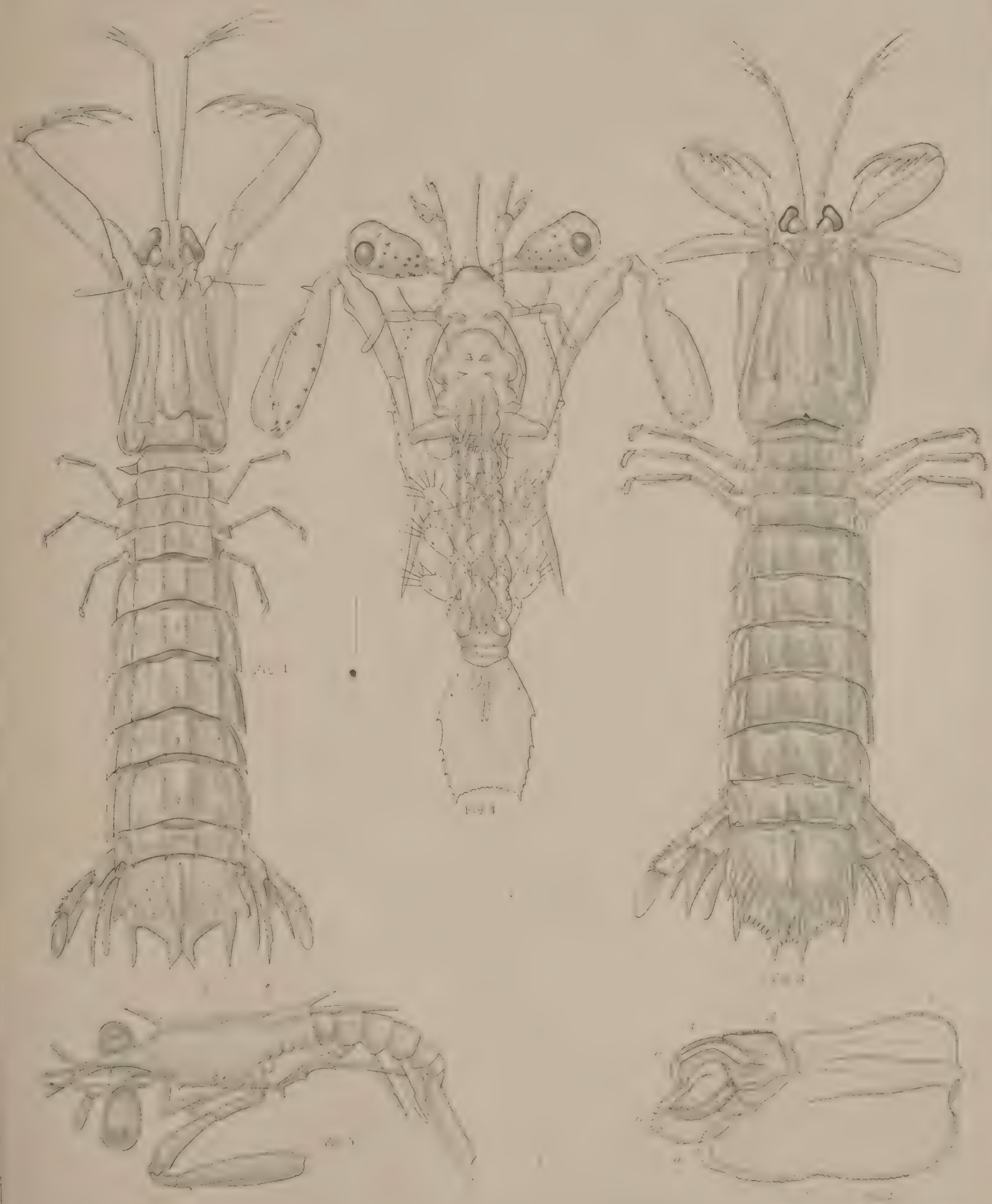

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PLATE II.

## PLATE II.

### Squilla (Alima).

Fig. 1. *Squilla chlorida*, n. sp., from Amboina. Dorsal view of male specimen, one and one-half inches long (p. 40).

Fig. 2. *Squilla chlorida.* Outline of telson; more enlarged.

Fig. 3. *Squilla chlorida.* Anterior end of body; enlarged.

Fig. 4. *Squilla chlorida.* Raptorial claw; enlarged.

Fig. 5. *Squilla chlorida.* Endopodite of first abdominal appendage of male; enlarged, from a drawing by Mr. G. B. Haldeman. A, basal joint; B, terminal joint; *a*, outer lobe; *b*, inner lobe; *c*, suture; *d*, retinaculum; *e*, fixed limb of petasma; *f*, moveable limb of petasma.

Fig. 6. *Squilla quinquedentata*, from the Marquesas Islands. First abdominal appendage of male, from a drawing by Mr. G. B. Haldeman (reference letters as in fig. 5).

Fig. 7. *Squilla empusa*, from Beaufort, N. C. First abdominal appendage of a male, from a drawing by Mr. G. B. Haldeman.

Fig. 8. *Squilla fasciata*, from Japan. Raptorial claw of male; enlarged (p. 37).

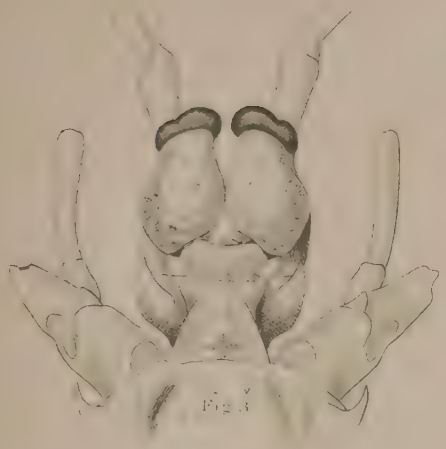

Fig. 3

Fig. 1

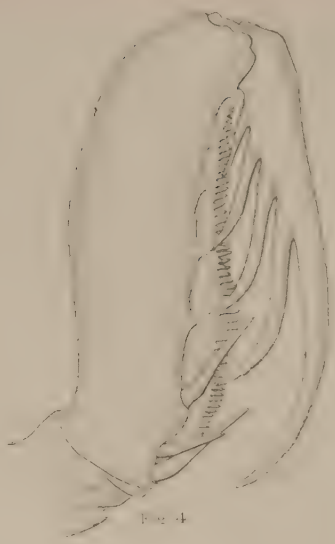

Fig. 4

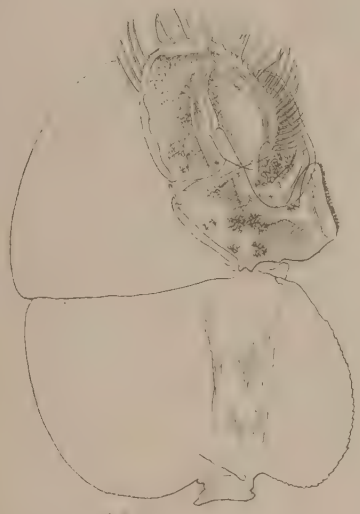

Fig. 7

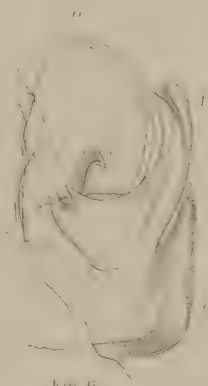

Fig. 6

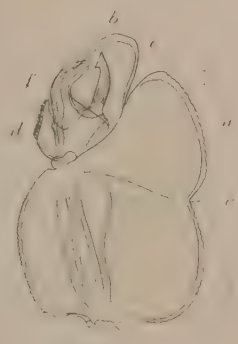

Fig. 5



Fig. 2

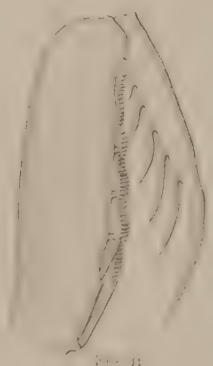

Fig. 8

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SQUILLA (ALIMA)

# PLATE III.

## PLATE III.

### Squilla.

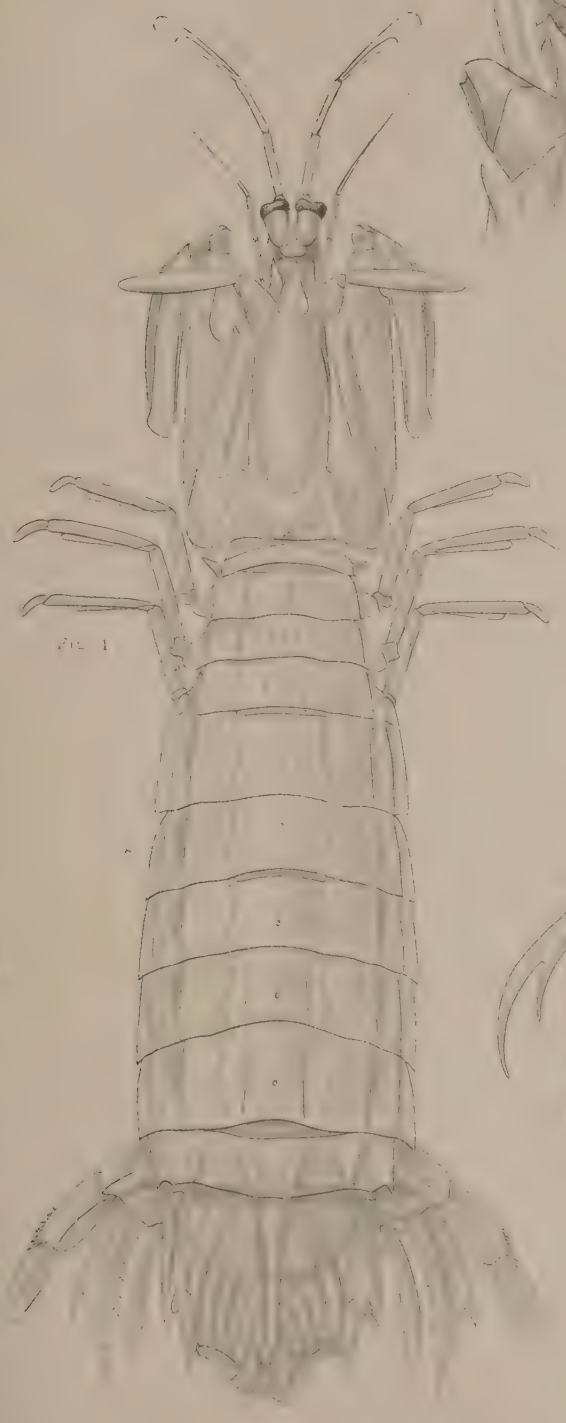
Fig. 1. *Squilla lata*, n. sp., from Arafura Sea, Dorsal view of a female specimen; twice the natural size (p. 34).

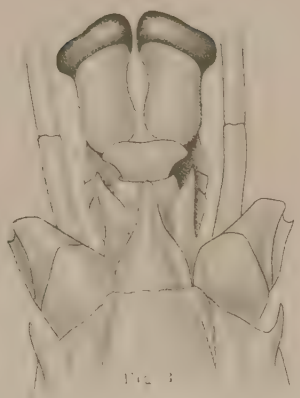
Fig. 2. *Squilla lata*. Raptorial claw; enlarged.

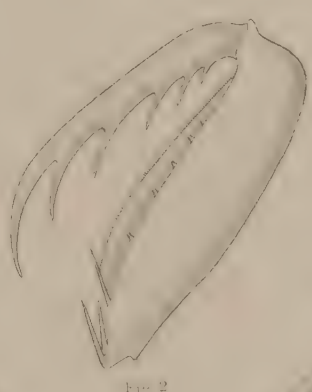
Fig. 3. *Squilla lata*. Anterior end of body; enlarged.

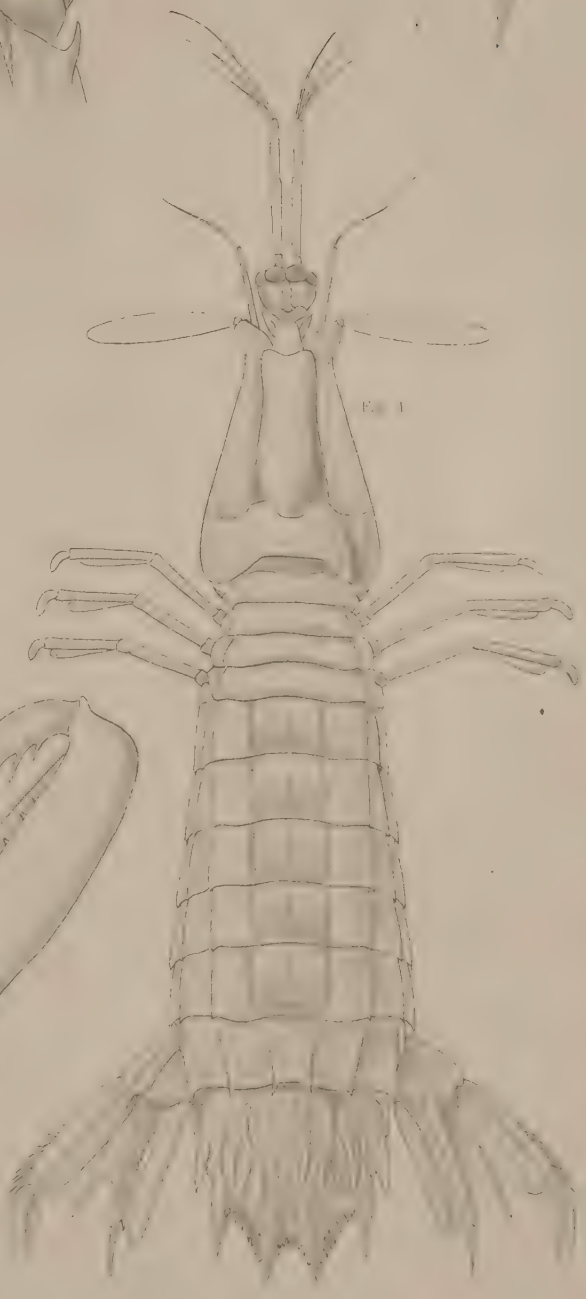
Fig. 4. *Squilla fasciata*, from Japan. Dorsal view of a male specimen; three times natural size.

Fig. 5. *Squilla fasciata*. Submedian spine of telson; enlarged to show secondary spinules.









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SQUILLA

PLATE IV.

## PLATE IV.

### Squilla (Alima).

Fig. 1. *Gonodactylus* (*Erichthoidina*). Telson of the specimen shown in Pl. XII. fig. 3 (pp. 55, 113).

Fig. 2. Mandible of the same larva.

Fig. 3. Maxilla of the same larva.

Fig. 4. *Squilla* (*Alima*) *gracilis*, from St. Vincent. Stage No. 2, 6·91 mm. long (p. 84).

Fig. 5. *Squilla* (*Alima*) *gracilis*, from St. Vincent. Stage No. 4, 11·54 mm. long.

Fig. 6. *Squilla* (*Alima*) *gracilis*, from St. Vincent. Stage No. 5, 17·38 mm. long.

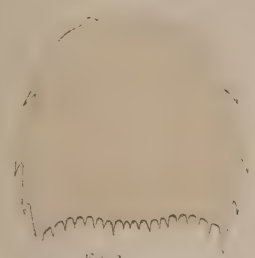


Fig. 1

Fig. 2

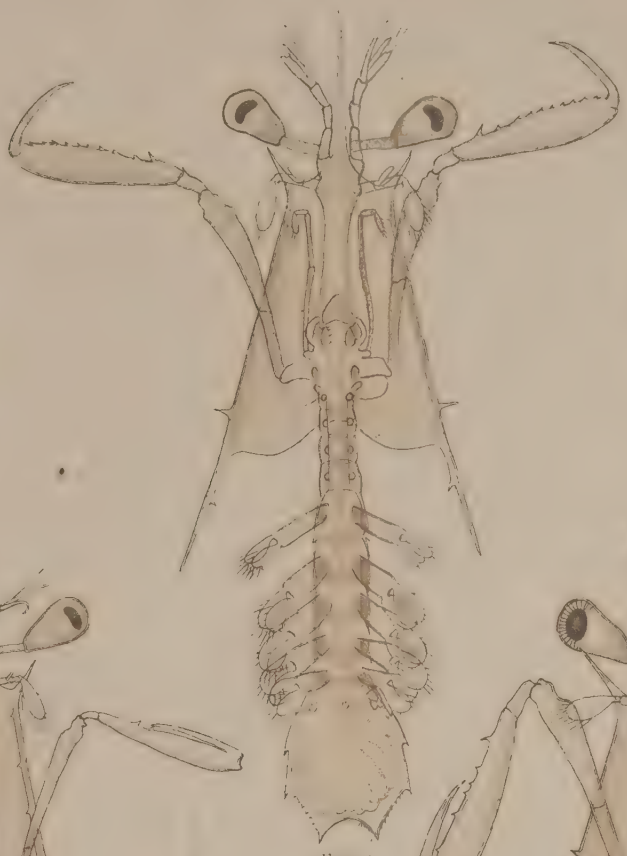


Fig. 5

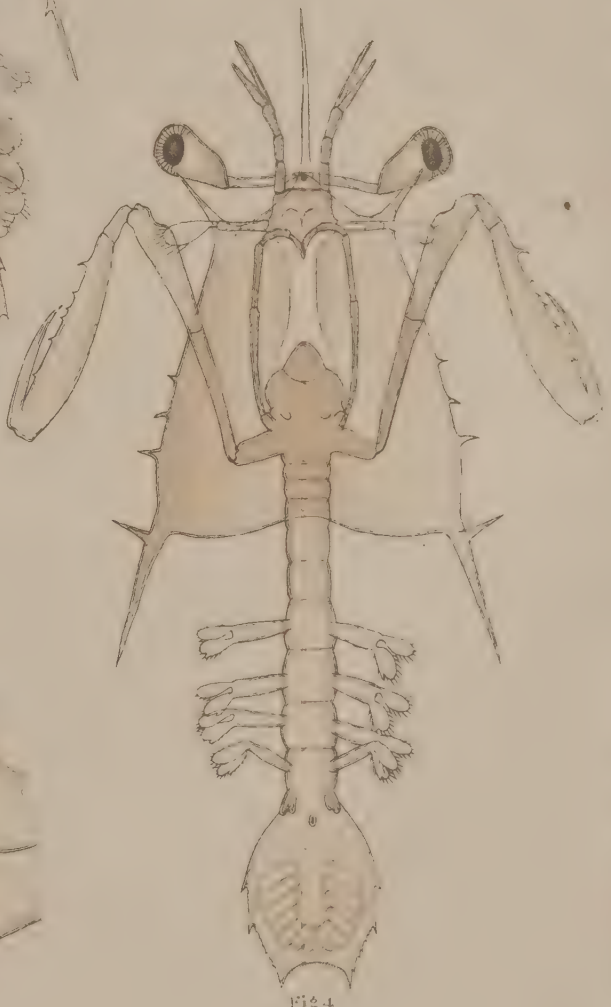


Fig. 4

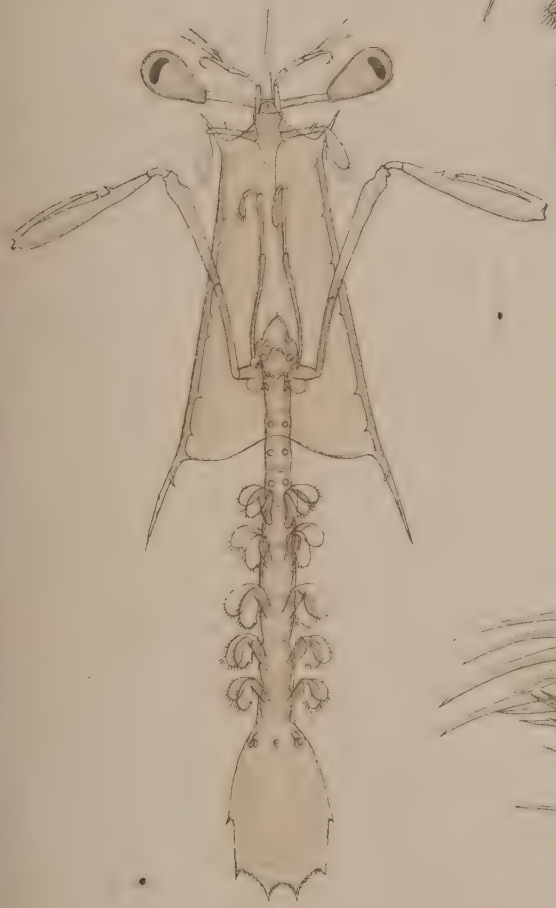


Fig. 6

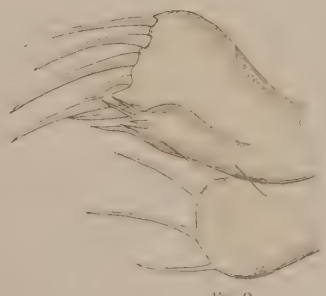


Fig. 3

J. HOGG & CO. Lith.

SQUILLA (ALIMA)

# PLATE V.

## PLATE V.

Fig. 1. First maxilla of the larva shown in fig. 5.

Fig. 2. Second maxilla of same.

Fig. 3. *Squilla* (*Alima*) *gracilis*, from St. Vincent. Stage No. 3 ; 9·18 mm. long (p. 84).

Fig. 4. *Gonerichthus* larva, from St. Vincent (p. 113).

Fig. 5. *Erichthoidina*. Ventral view of the anterior end of body of larva shown in Pl. XII. fig. 1.

Fig. 6. Abdominal appendage of the *Coronis* larva shown in Pl. XII. fig. 4.

Fig. 7. First antenna of the larva shown in Pl. XII. fig. 3.

Fig. 9. Telson of the larva shown in Pl. XII. fig. 2.

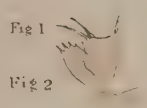


Fig 1

Fig 2

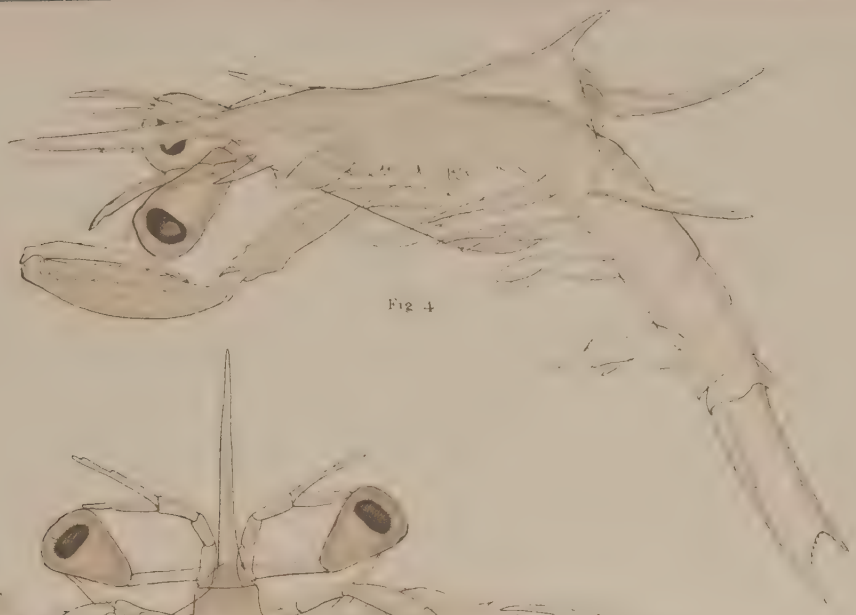


Fig 4

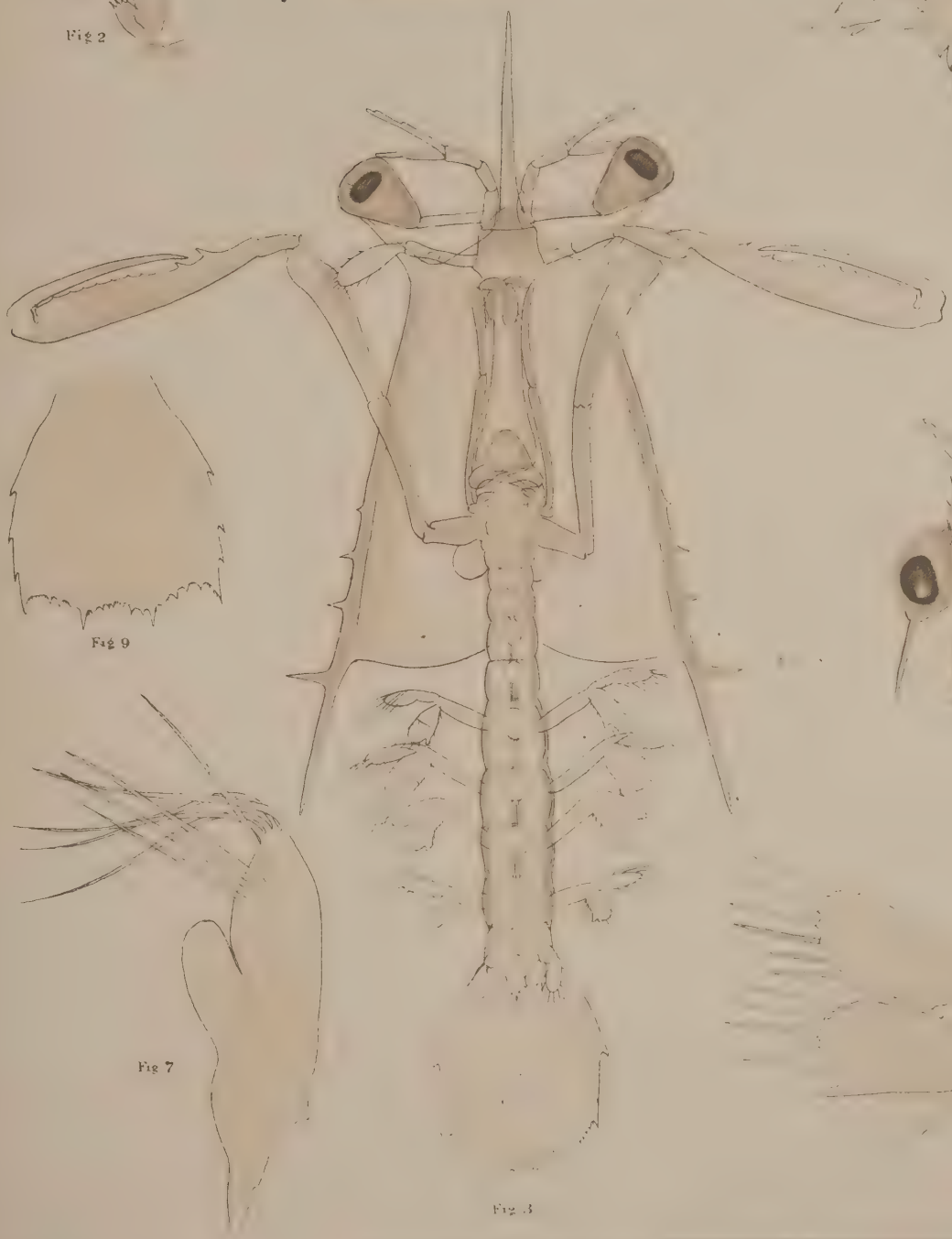


Fig 3



Fig 9

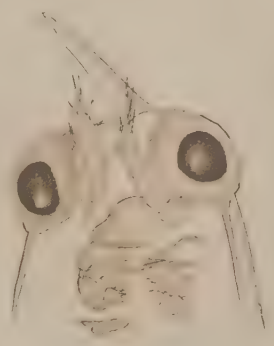


Fig 5



Fig 7

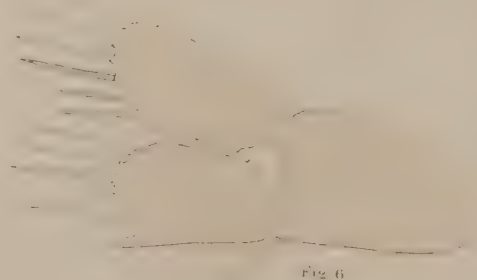


Fig 6

A. HOEN & CO. Lith.

PLATE VI.

## PLATE VI.

### Lysioerichthus.

Fig. 1. *Lysiosquilla* (?) (*Erichthoidina*). Telson of the larva shown in Pl. XII. fig. 1.

Fig. 2. Seventh thoracic limb of the larva shown in Pl. XII. fig. 6.

Fig. 3. *Squilla* (*Alima*) *gracilis*, from St. Vincent. Stage No. 6 ; 42·83 mm. long.

Fig. 4. *Squilla* (*Alima*) *gracilis*. Stage No. 6. Mouth parts more highly magnified.

Fig. 5. *Squilla* (*Alima*) *gracilis*. Stage No. 6. Anterior end of body more magnified.

Fig. 6. First abdominal appendage of the larva shown in Pl. XII. fig. 6.

Fig. 7. Telson of a *Pseuderichthus* larva from Volcano, similar to the one shown in Pl. XII. fig. 6, but $1\frac{3}{4}$ inches long.

Fig 1

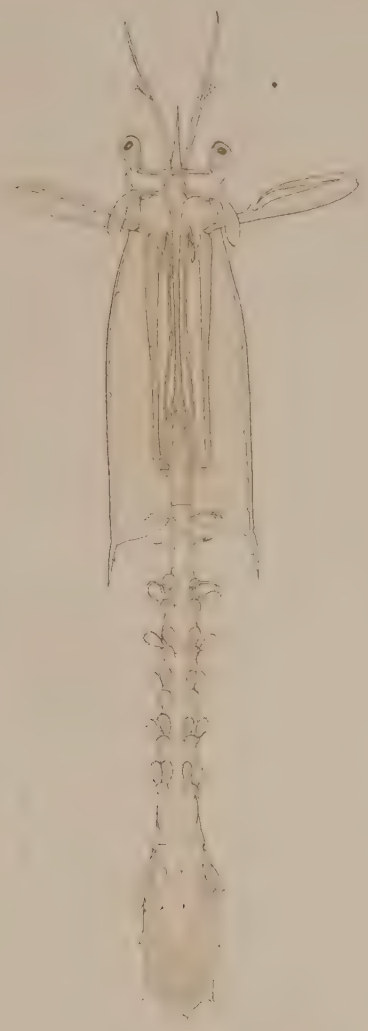


Fig 3

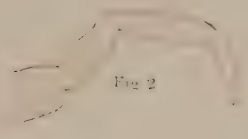


Fig 2

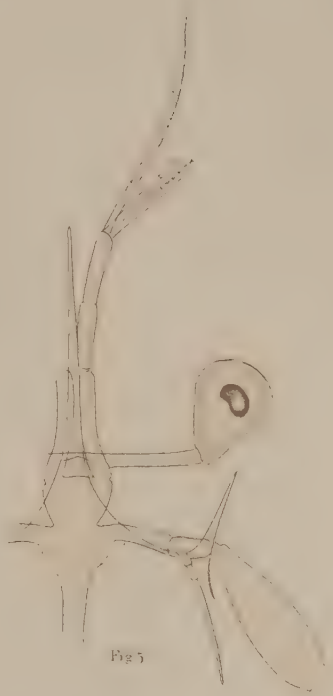


Fig 5

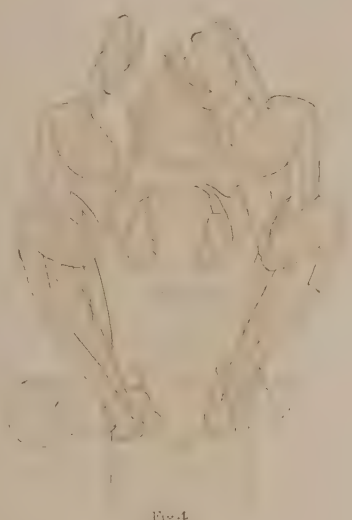


Fig 4

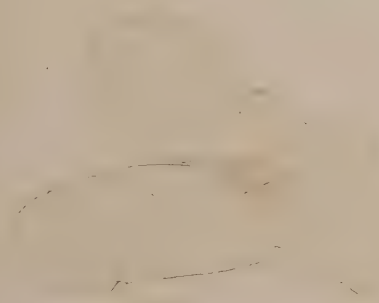


Fig 6

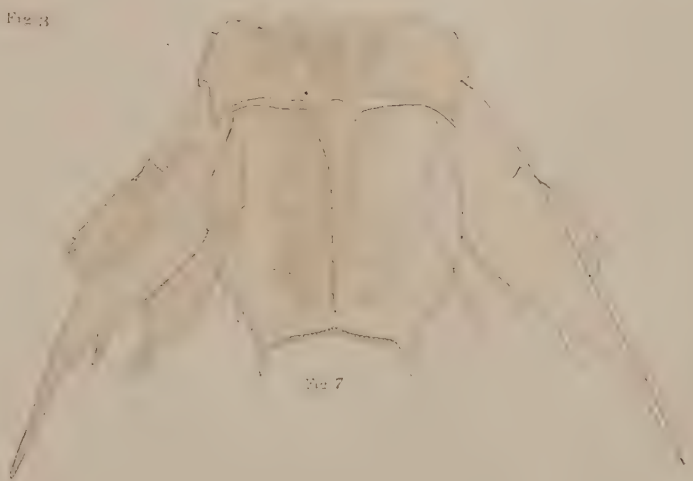


Fig 7

A. HOEN & CO. Lith.

LYSIOERICHTHUS

# PLATE VII.

## PLATE VII.

### Squilla (Alima).

Fig. 1. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 2; 4·9 mm. long (p. 93).

Fig. 2. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 3; 6·4 mm. long.

Fig. 3. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 4; 8·4 mm. long.

Fig. 4. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Outline of telson of stage No. 1; greatly magnified.

Fig. 5. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Outline of telson of stage No. 4.

Fig. 6. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Mouth parts of stage No. 1; greatly magnified.

Fig. 7. Raptorial claw of an *Alima* larva, $1\frac{1}{8}$ inches long, from the coast of Africa.

SQUILLA (ALIMA)

PLATE VIII.

## PLATE VIII.

### Squilla (Alima).

Fig. 1. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 5; 8·75 mm. long.

Fig. 2. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 6; 11·11 mm. long.

Fig. 3. *Squilla* (*Alima*) *macrophthalma*, from Cape Howe. Stage No. 7; 19 mm. long.

Fig. 4. *Squilla* (*Alima*) *gracilis*. Uropod of a fully-grown larva, collected between Api and Cape York.

Fig. 5. *Squilla* (*Alima*) *gracilis*. Raptorial claw of a fully-grown larva, from St. Vincent.

Fig. 6. *Squilla* (*Alima*) *gracilis*. Telson of larva shown in Pl. VI. fig. 4.

Fig. 7. Telson of an *Alima*, $1\frac{1}{8}$ inches long, from the coast of Africa.

Fig. 8. *Alimerichthus* from the South Atlantic; 8·715 mm. long.

SQUILLA (ALIMA)

# PLATE IX.

## PLATE IX.

SQUILLA (ALIMA) (ALIMERICHTHUS) (LYSIOSQUILLA) LYSIOERICHTHUS.

Fig. 1. *Squilla* (*Alima*) *bidens*, 1 inch long, from the Cape of Good Hope (p. 90).

Fig. 2. Telson and uropods of same larva.

Fig. 3. *Alimerichthus*, 15·52 mm. long, from the South Atlantic.

Fig. 5. Telson and uropods of a younger *Alimerichthus;* 8·715 mm. long.

Fig. 6. *Lysiosquilla* (*Lysioerichthus*). A larva of the subgenus *Coronis*, $\frac{70}{100}$ inch long, collected between Sydney and Wellington.

Fig. 7. Telson and uropods of same larva.

Fig. 8. Telson and uropods of a younger specimen.

Fig. 9. Side view of the carapace of the larva shown in fig. 6.

Fig. 10. Raptorial claw of the same larva.

Fig. 11. *Lysiosquilla* (*Lysioerichthus*) *triangularis*, from Rio Janeiro.

A. HOEN & CO. Lith.

SQUILLA (ALIMA ALIMERICHTHUS)
(LYSIOSQUILLA) LYSIOERICHTHUS

PLATE X.

## PLATE X.

(LYSIOSQUILLA).

Fig. 1. *Lysiosquilla maculata.* Raptorial claw of male; one-half natural size (p. 45).

Fig. 2. *Lysiosquilla maculata.* Raptorial claw of female; one-half natural size.

Fig. 3. *Lysiosquilla maculata.* Mandible.

Fig. 4. *Lysiosquilla maculata.* First maxilla.

Fig. 5. *Lysiosquilla maculata.* Second maxilla.

Fig. 6. *Lysiosquilla maculata.* First abdominal appendage of adult male; slightly enlarged. *e*, exopodite; A, basal joint of endopodite; B, terminal joint of endopodite.

Fig. 7. *Lysiosquilla* (*Lysioerichthus*) *maculata;* magnified 5 diameters.

Fig. 8. *Lysiosquilla* (*Coronis*) *excavatrix*, n. sp.; male, magnified 2 diameters.

Fig. 9. *Lysiosquilla* (*Coronis*) *excavatrix.* First maxilla.

Fig. 10. *Lysiosquilla* (*Coronis*) *excavatrix.* Second maxilla.

Fig. 11. *Lysiosquilla* (*Coronis*) *excavatrix.* Raptorial claw of male.

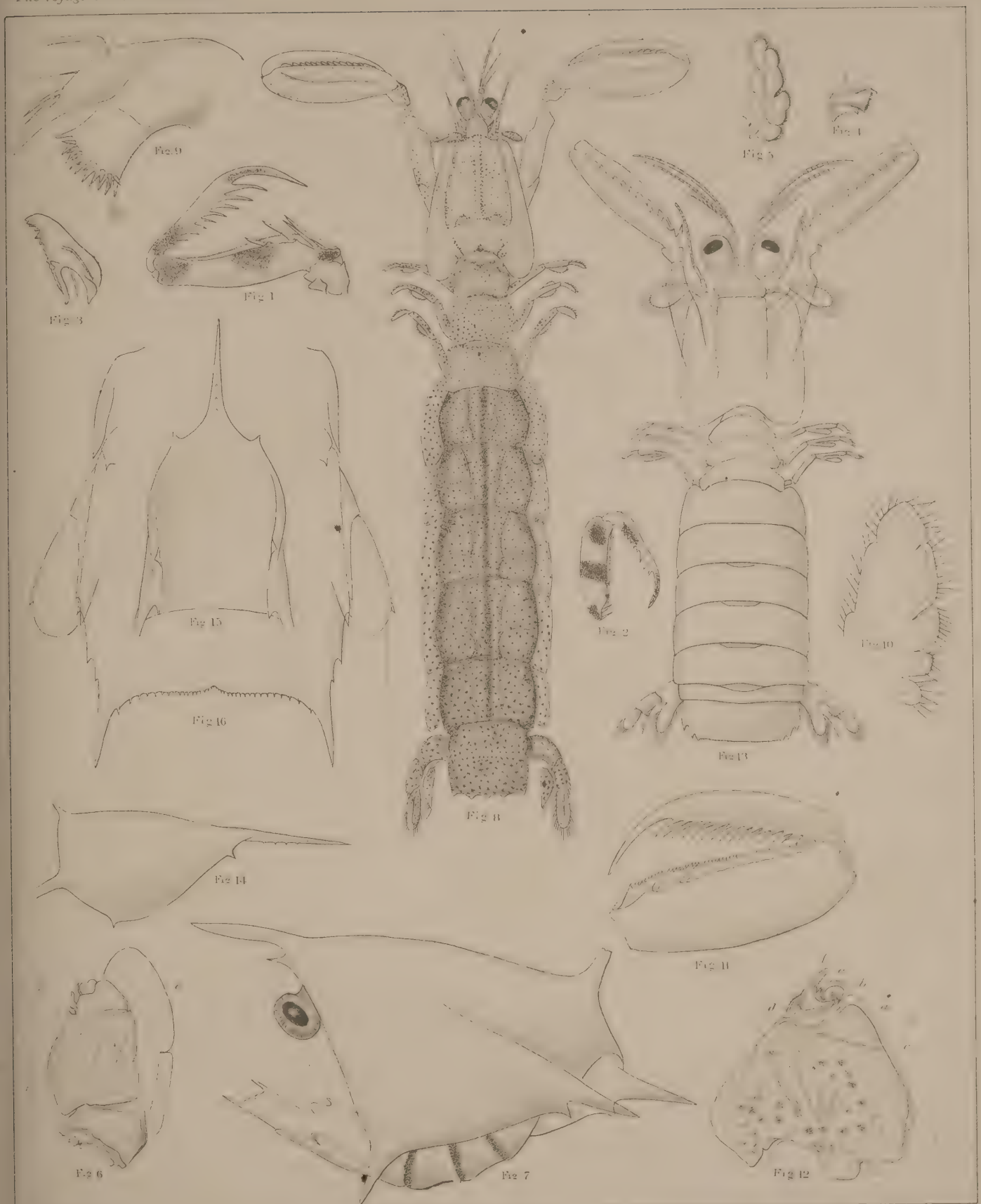
Fig. 12. *Lysiosquilla* (*Coronis*) *excavatrix.* Endopodite of first abdominal appendage of adult male; greatly enlarged (reference letters as in fig. 6; and, in addition, *a*, outer lobe; *b*, inner lobe; *c*, suture; *d*, retinaculum; *e*, fixed limb; *f*, movable limb of petasma).

Fig. 13. *Lysiosquilla* (*Coronis*) *excavatrix.* Young specimen; enlarged 5 diameters.

Fig. 14. *Lysiosquilla* (*Coronis*) *excavatrix.* Side view of the carapace of the larval skin, $\frac{12}{20}$ inch long, from which the young specimen shown in fig. 13 moulted.

Fig. 15. *Lysiosquilla* (*Coronis*) *excavatrix.* Ventral view of same.

Fig. 16. *Lysiosquilla* (*Coronis*) *excavatrix.* Telson and uropods of the same larva, $\frac{8}{40}$ inch long, $\frac{7}{40}$ inch wide.




A HOEN & CO Lith.

(LYSIOSQUILLA)

# PLATE XI.

## PLATE XI.

### Lysioerichthus.

Fig. 1. *Lysiosquilla* (*Coronis*) *excavatrix.* Ventral view of a young *Erichthus* larva (*Erichthus multispinous*, Claus).

Fig. 2. *Lysiosquilla* (*Coronis*) *excavatrix.* Side view of same larva.

Fig. 3. *Lysiosquilla* (*Coronis*) *excavatrix.* Side view of older larva.

Fig. 4. *Lysiosquilla maculata.* Ventral view of *Squillerichthus* larva.

Fig. 5. *Lysiosquilla maculata.* Marginal spinules of telson.

Fig. 6. *Lysiosquilla* (*Lysioerichthus*) *triangularis*, from Rio Janeiro.

Fig. 7. Telson and uropods of same.

Fig. 8. Raptorial claw of same.

Fig. 9. Seventh thoracic appendage of same.

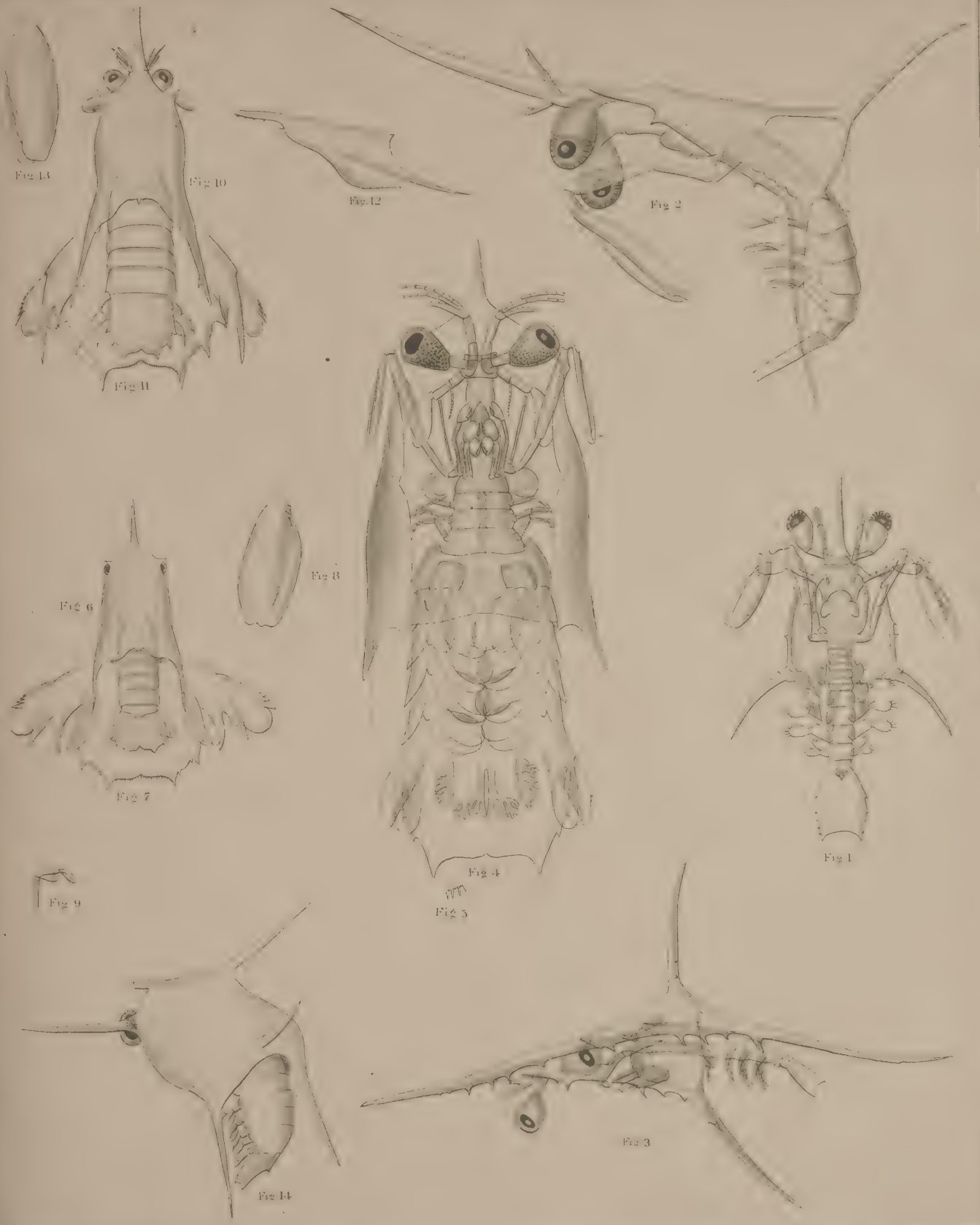
Fig. 10. *Lysiosquilla* (*Lysioerichthus*), $\frac{9}{10}$ of an inch long, collected between Papua and Japan.

Fig. 11. Telson and uropods of same.

Fig. 12. Side view of carapace of same.

Fig. 13. Raptorial claw of same.

Fig. 14. *Lysioserichthus* (?), from Kandavu Island, Fiji.




LYSIOERICHTHUS

A HOEN & CO Lith.

PLATE XII.

## PLATE XII.

1–3. Erichthoidina. 4. Lysioerichthus. 5. Gonerichthus. 6. Pseuderichthus.

Fig. 1. *Erichthoidina* (*Lysiosquilla ?*), from Honolulu. Zeiss, A, 2.

Fig. 2. Older stage of same.

Fig. 3. *Erichthoidina* (*Gonodactylus ?*), from St. Vincent, Cape Verde. Zeiss, A, 2.

Fig. 4. *Lysiosquilla* (*Lysioerichthus*) *minutus*, from St. Vincent, Cape Verde. Stage No. 1; 4·16 mm. long.

Fig. 5. *Gonodactylus* (*Gonerichthus*), from St. Vincent, Cape Verd. Zeiss, A, 2.

Fig. 6. *Pseudosquilla* (*Pseuderichthus*), 1·14 inches long, collected between Tenerife and St. Thomas.

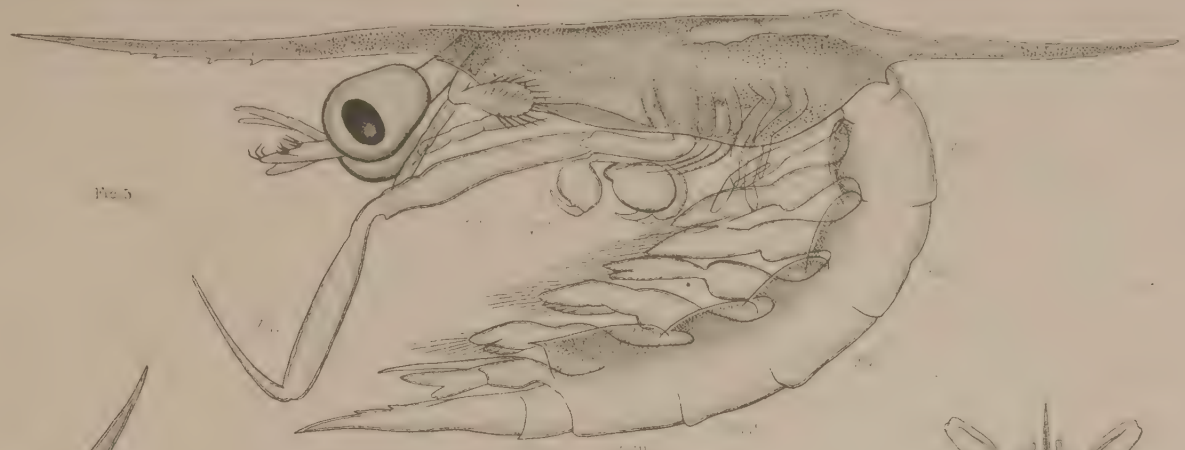


Fig. 5

Fig. 2

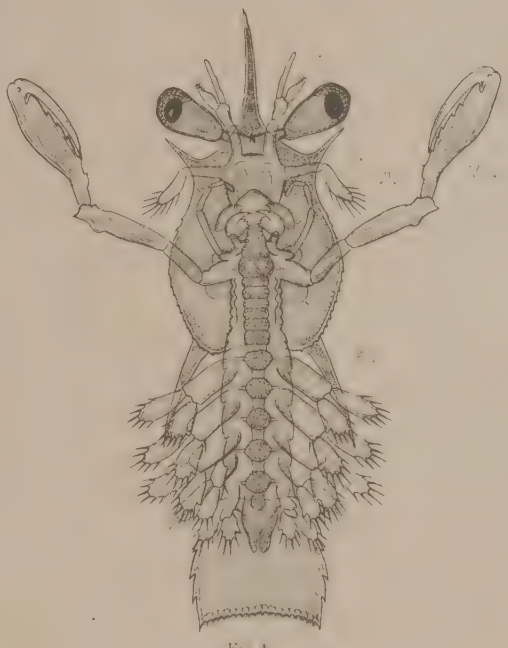


Fig. 4

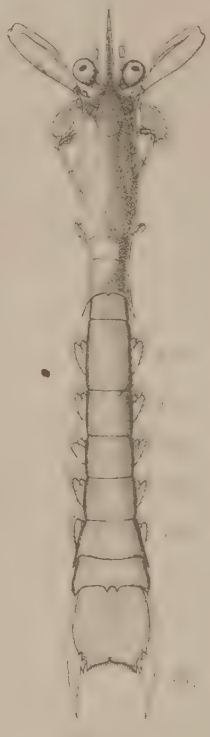


Fig. 6

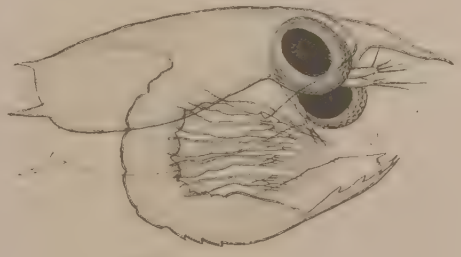


Fig. 1

Fig. 3

W. K. BROOKS, Del.

A. HOEN & CO. Lith.

1–3 ERICHTHOIDINA 4 LYSIOERICHTHUS

5 GONERICHTHUS 6 PSEUDERICHTHUS

# PLATE XIII.

## PLATE XIII.

### Squilla (Alima).

Fig. 1. *Coronis* (*Erichthus*) *minutus*, from St. Vincent. Hind body of the larva shown in Pl. XII. fig. 4, without the appendages (p. 105).

Fig. 2. Mouth parts of same larva.

Fig. 3. Telson of a slightly older larva. Stage No. 2; 5·20 mm. long.

Fig. 4. Antenna of same larva.

Fig. 5. Nervous system of same larva.

Fig. 6. *Coronis* (*Erichthus*) *minutus*, from St. Vincent. Stage No. 3; 6·46 mm. long.

Fig. 7. *Coronis* (*Erichthus*) *minutus*, from St. Vincent. Stage No. 4; 10·16 mm. long.

Fig. 8. Telson and uropods of same larva.

Fig. 9. Telson of a larva similar to the one shown in Pl. XII. fig. 5.

Fig. 10. Telson of the larva shown in Pl. V. fig. 4.

Fig. 11. Profile view of the carapace of the larva shown in fig. 3.

Fig. 12. Anterior end of the body of the larva shown in Pl. XII. fig. 6.

Fig. 13. Thoracic limb of same larva.

Fig. 14. Raptorial claw of the larva shown in Pl. XII. fig. 6.

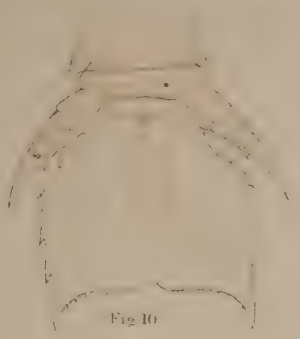


Fig 10

Fig 14

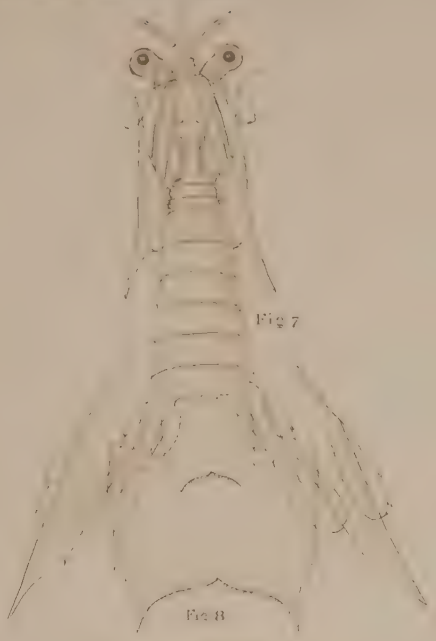


Fig 7

Fig 8

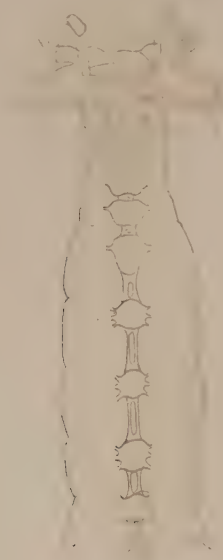


Fig 5

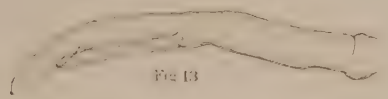


Fig 13

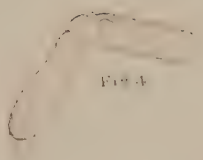


Fig 4

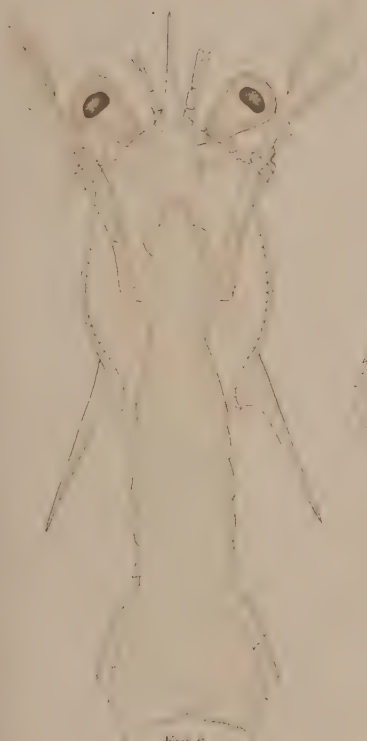


Fig 6

Fig 9

Fig 1

Fig 2

Fig 3

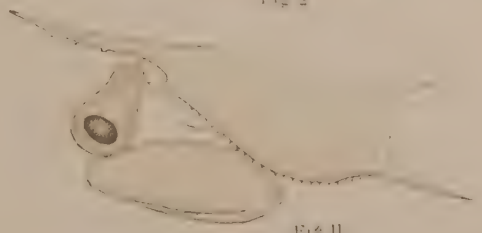


Fig 11

Fig 12

A. ROSS & CO. Lith.

SQUILLA (ALIMA)

PLATE XIV.

## PLATE XIV.

### Gonodactylus. Protosquilla.

Fig. 1. *Gonodactylus graphurus* (Miers). Side view of a male specimen, $2\frac{14}{100}$ inches long, from Cape York (p. 58).

Fig. 2. *Protosquilla cerebralis*, n. sp. Side view of a female specimen, $1\frac{27}{100}$ inches long, from Fiji.

Fig. 3. *Protosquilla cerebralis.* Raptorial claw (p. 72).

Fig. 4. *Gonodactylus graphurus.* Dorsal view of sixth abdominal somite of a male specimen, with telson and uropods.

Fig. 5. *Gonodactylus glabrous.* Dorsal surface of sixth abdominal somite, with telson and uropods (p. 62).

Fig. 6. *Gonodactylus graphurus.* Anterior end of body, greatly enlarged.

Fig 3

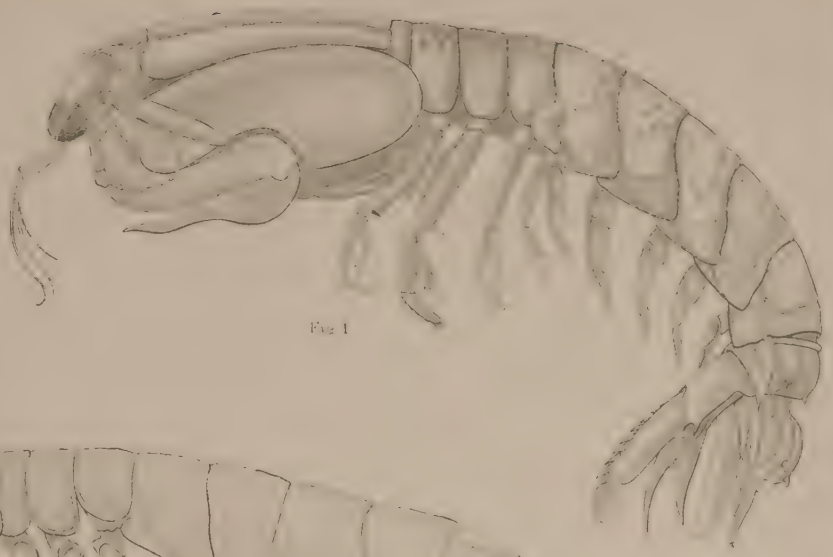


Fig 1

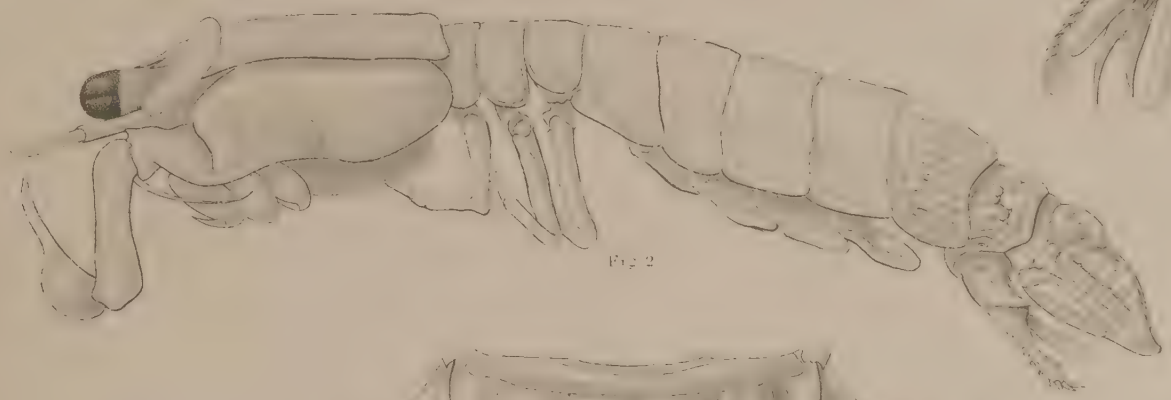
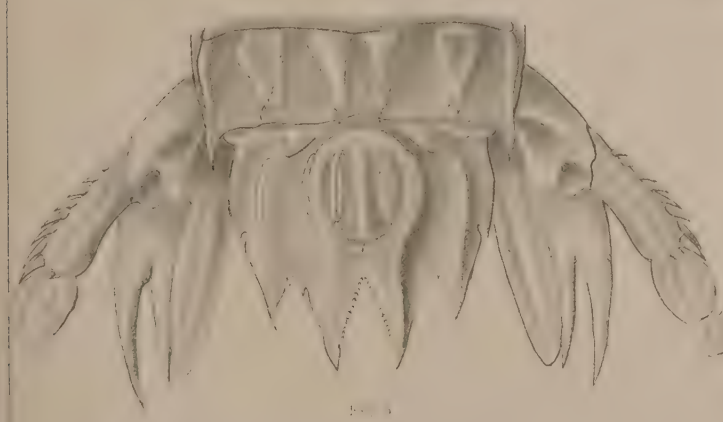
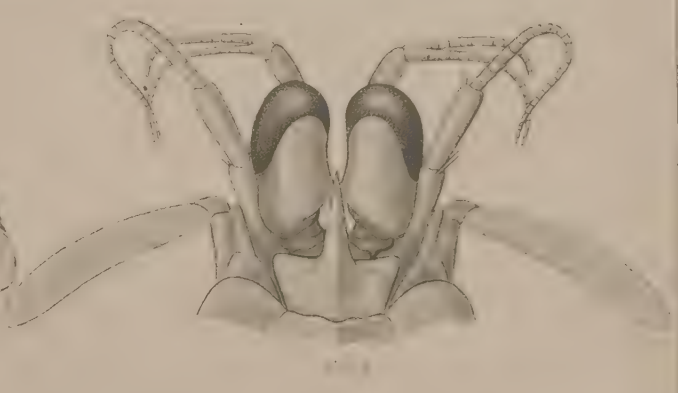


Fig 2

Fig 4





W. & A. K. BROOKS, Del. A. HUTTON & CO. Lith.

GONODACTYLUS PROTOSQUILLA

# PLATE XV.

## PLATE XV.

### Gonodactylus. Protosquilla.

Fig. 1. *Gonodactylus* (*Gonerichthus*). Carapace of a *Gonerichthus*-larva, $\frac{6}{10}$ inch long, smaller than the one shown in fig. 11, but older, from the Celebes Sea.

Fig. 2. *Protosquilla elongata*, n. sp. Dorsal view of a specimen, $\frac{77}{100}$ inch long, from St. Vincent (p. 67).

Fig. 3. *Gonodactylus graphurus*. Raptorial claw.

Fig. 4. *Gonodactylus chiragra*. Endopodite of the first abdominal appendage of a male specimen. A, distal joint; *a*, its outer lobe; *b*, its inner lobe; B, basal joint; *c*, *c*, suture; *d*, retinaculum; *e*, fixed limb of petasma; *f*, movable limb.

Fig. 5. *Gonodactylus* (*Gonerichthus*). Telson and uropods of the larva shown in fig. 1.

Fig. 6. *Gonodactylus* (*Gonerichthus*). Dorsal view of a *Gonerichthus*-larva, $1\frac{28}{100}$ inches long, from the West Pacific.

Fig. 7. *Gonodactylus glabrous*, n. sp. Dorsal view of a specimen, $2\frac{5}{100}$ inches long, from Samboangan Reef (p. 62).

Fig. 8. *Gonodactylus graphurus*. Petasma of a male specimen; reference letters as in fig. 4.

Fig. 9. *Gonodactylus glabrous*. First abdominal appendage of a male; reference letters as in fig. 4.

Fig. 10. *Pseudosquilla ciliata*. Endopodite of first abdominal appendage of a male; reference letters as in fig. 4.

Fig. 11. *Gonodactylus* (*Gonerichthus*). Side view of a *Gonerichthus*-larva, $1\frac{28}{100}$ inches long, from the West Pacific.

Fig. 12. *Protosquilla elongata*. Magnified view of the ventral surface of the telson of the specimen shown in fig. 2.

Fig. 3

Fig. 1

Fig. 5

Fig. 4

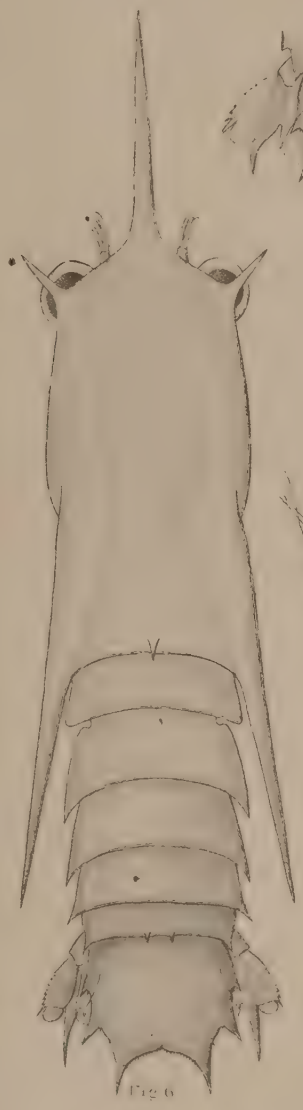


Fig. 6

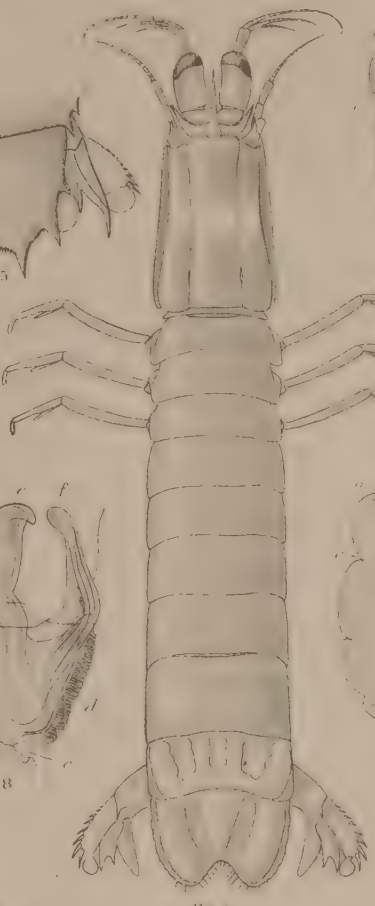
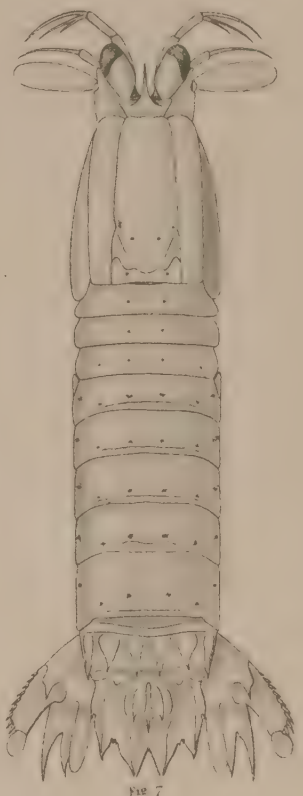


Fig. 2



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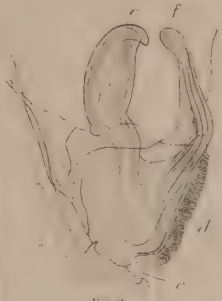

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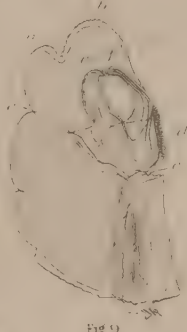

Fig. 9

Fig. 10

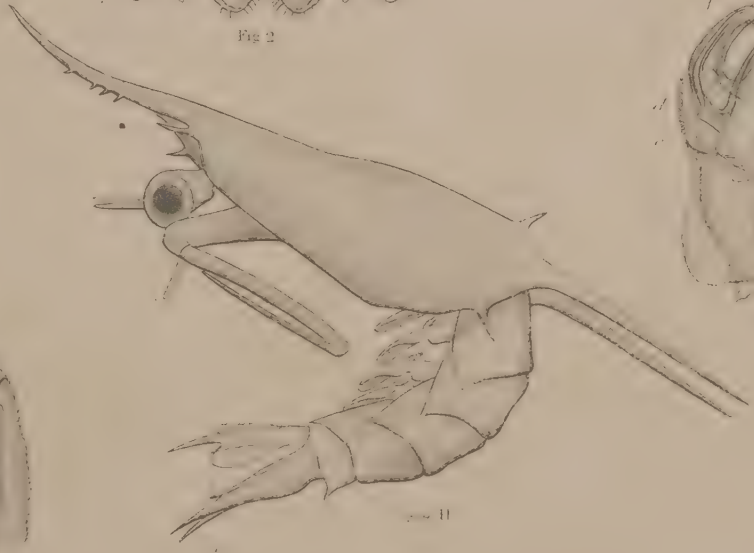

Fig. 11

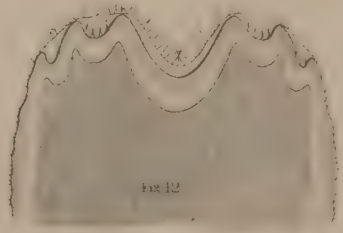

Fig. 12

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GONODACTYLUS PROTOSQUILLA

PLATE XVI.

## PLATE XVI.

PROTOSQUILLA.

Fig. 1. *Protosquilla guerinii* (White). Dorsal view of a female specimen, $1\frac{12}{100}$ inches long, from Honolulu (p. 75).

Fig. 2. *Protosquilla cerebralis*, n. sp. Dorsal view of a female specimen, $1\frac{27}{100}$ inches long, from Fiji (p. 72).

Fig. 3. *Protosquilla cerebralis.* Uropod of the specimen shown in fig. 3, from below.

Fig. 4. *Protosquilla elongata.* Anterior end of the body of the specimen shown in Pl. XV. fig. 2.

Fig. 5. *Gonodactylus.* Telson of a young specimen of a *Chiragra*-like species, from 188 fathoms, at Station 208, near the Philippine Islands.

Fig. 6. *Protosquilla guerinii.* Ventral view of the telson and uropods of the specimen shown in fig. 1.

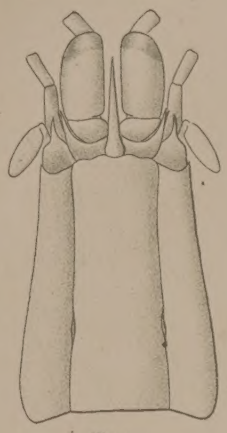

Fig.4

Fig.6

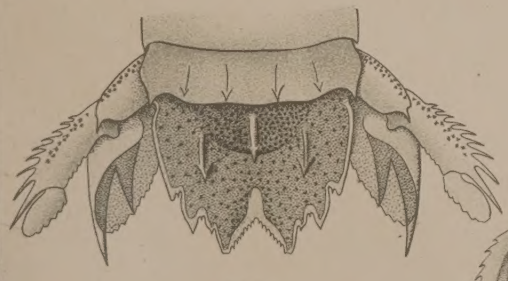

Fig.5

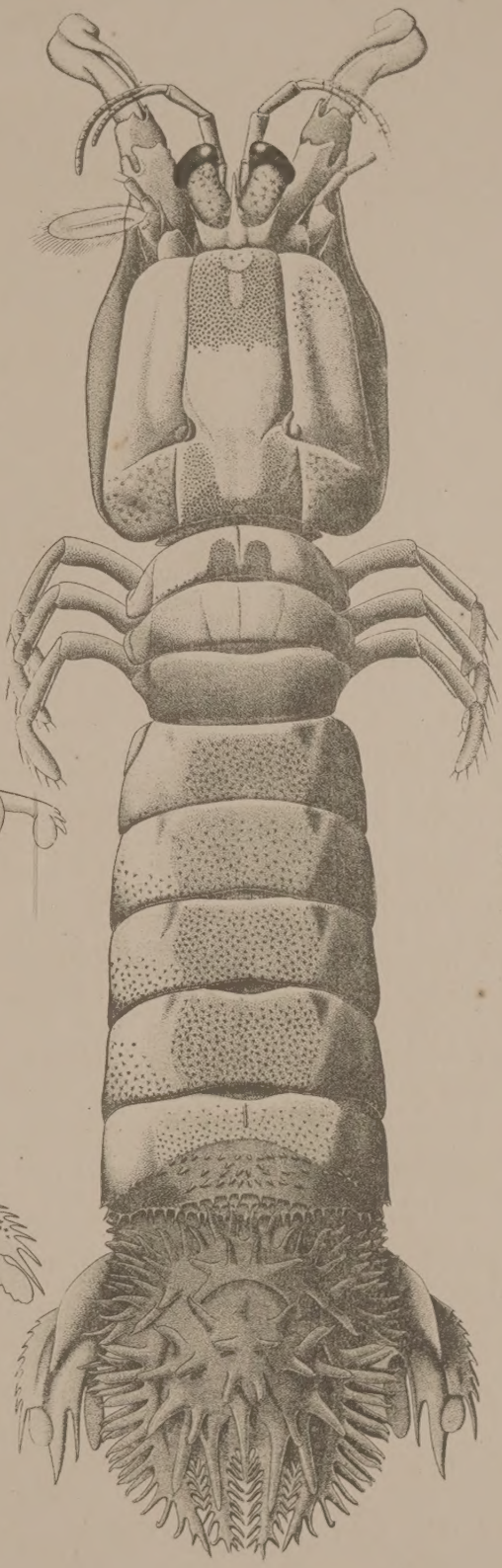

Fig.1

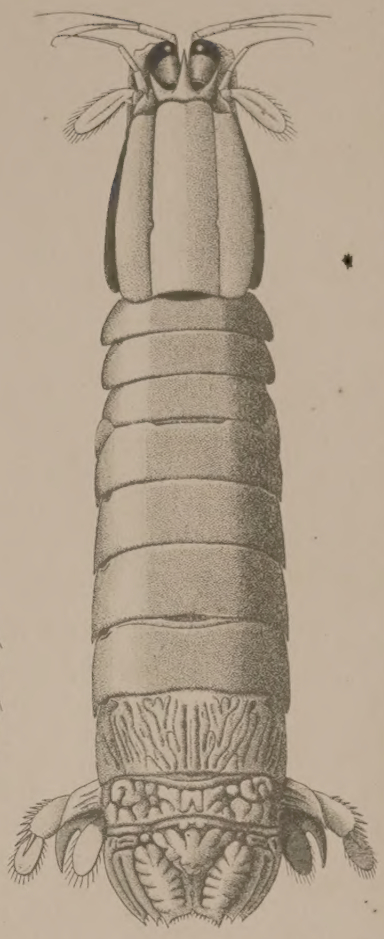

Fig.2

Fig.3

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PROTOSQUILLA